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21st Annual Report of the Proceedings

OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers,

HELD AT

COLUMBUS O., JANUARY 24-6, 1900.

PUBLISHED BY THE SOCIETY.

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DAYTON, OHIO.

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OHIO SOCIETY

....OF....

Surveyors and Civil Engineers.

Organized January 15, 1880.
Incorporated January 14, 1885.

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DR. EDWARD ORTON.

Edward Orton was born at Deposit, Delaware County, N. Y., March 9, 1829. He died at Columbus, Ohio, October 16, 1899.

Under the tuition of his father, Rev. Samuel G. Orton, he was fitted for college, with the exception of two years spent at Westfield and Fredonia Academies. In 1845, at the age of 16 years, he entered the sophomore class of Hamilton College, his father's *alma mater*, and graduated with high honors in 1848. The following year, 1848–49, he spent as assistant in an academy at Erie, Pa., after which he entered Lane Theological Seminary, at Cincinnati, Ohio, and remained one year under the instruction of Dr. Lyman Beecher.

In 1851, Mr. Orton taught in the Delaware Literary Institute, at Franklin, N. Y., where he met with much success. The following year he entered the Lawrence Scientific School of Harvard University to become more proficient in the natural sciences, after which he returned to the Delaware Institute as teacher.

But to carry out his long cherished purpose of entering the ministry he entered Andover Theological Seminary in 1854, and shortly after became the acting pastor of the Presbyterian Church at Downsville, Delaware Co., N. Y., and was ordained January 1, 1856, by the Delaware Presbytery.

In September, 1856, Mr. Orton accepted the professorship of natural sciences in the State Normal School, at Albany, N. Y., which he resigned after three years of successful service.

From 1859 to 1863, Mr. Orton was principal of an academy at Chester, Orange Co., N. Y., where his success was so marked that he was elected professor of natural history in Antioch College, Yellow Springs, Ohio. This position he held until he was elected President of Antioch, June, 1872.

In 1873, Mr. Orton was elected professor of geology and president of the new Agricultural and Mechanical College, located at Columbus, O, which, in 1878, changed its name to the Ohio State University. The presidency he resigned in 1881, but retained the professorship of geology until his death.

To none other in the long list of distinguished men who have served the Ohio State University can it more justly bring its tribute of respect and gratitude than to Dr. Edward Orton. "As its president he had always striven to have a high educational standard maintained in every department; he had set his face like flint againt the seductive but dangerous policy of lowering the requirements for admission in order to swell the roll

Edward Orton

of students; he stood firm for quality rather than for numbers." He maintained that the true university does not depend upon numbers, but on a few great men, unknown, perhaps, to the outer world, recognized where known, as potent in intellect and lofty in character. It can only exert through high-minded teachers a strong ethical and devout influence; implant in the breasts of its students exalted sentiments and a worthy ambition, and infuse into their hearts the sense of honor, of duty, and of responsibility. He would often say that teachers and scholars are not bound together as task-masters and slaves, as jailers and captives, but as associates, inquisitive, co-operative, and resolute, devoted to the formation of intellectual habits, the enjoyment of literary or scientific heritage, and the advancement of knowledge.

"In conversation, Dr. Orton disliked to descend to trivialities and gossip; he paid you habitually the exquisite compliment of assuming that you were interested in high thinking and noble actions; that you were reading the best books and knew, or at least wished. to know, the most recent discoveries in travel and exploration, the latest scientific hypothesis, the most fruitful criticism or theory in historical research, in morals, in problems relating to public charity or to the health of the community."

"Early in December, 1891, he gave an address at Antioch College, and while returning to Columbus the following day suffered a stroke of paralysis, which wholly deprived him of the use of his left arm and caused a perceptible limp in his gait, but left his mental powers unimpaired. The blow was a cruel one; by it, as he wrote to a friend, he 'became an old man in a day.' But he strove valiently against partial helplessness and unavoidable dependence upon the kind offices of friends. He bore with singular patience the resulting burden of disability. He took up his duties again with resolution, though always under the shadow of an inevitable fate."

In person, Dr. Orton was of well built and robust frame of medium height, active and vigorous in movement, and capable of long and continued physical and intellectual labor. His countenance was indicative of his keen, ready mind. He was frank, open-hearted, and always ready to grant any favor that was in his power to bestow. He always met his classes in a kindly and social spirit, and his lecture room was filled with students who were anxious to place themselves under his influence and instruction. His favorite exercise was walking and he surprised his classes by his speed and endurance while on their geological excursions.

Hamilton College, his *alma mater*, conferred upon him the degree of Ph. D. in 1875, and the Ohio State University, at the close of his presidency in 1881, gave him the degree of LL. D.

He was a member of many scientific bodies and a constant contributor to the scientific and technical journals of the country and the various volumes of the "Geological Surveys of Ohio," with

which he was connected since 1869 and as state geologist since 1882. The extent and importance of his contributions to science made him famous and to be recognized as an authority. In later years he devoted himself chiefly to economic geology, and to problems of sewage disposal and public water supply.

It is a significant fact that not all men are of equal value. Not many Platos: only one, to whom a thousand lesser minds look up and learn to think. Not many Dantes: one, and a thousand poets tune their harps to his and repeat his notes. Not many royal hearts. Happy the seat of learning blessed with a few great minds and a few great hearts. One such was Dr. Edward Orton, who, in a high degree, united the dignity that commands respect, the erudition that inspires confidence, the kindness that wins affection. Students would respond to the influence of his benign presence as flowers and trees respond with boughs brilliant and fragrant to the sunshine of spring.

Twenty-First Annual Report

OF THE

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS

OUTLINE OF PROCEEDINGS.

The Twenty-first Annual Meeting of the Ohio Society of Surveyors and Civil Engineers, which was held at the Great Southern Hotel, Columbus, was called to order by the President, Mr. E. A. Kemmler, Wednesday, at 2:00 P. M., January 24, 1900.

The report of the Secretary was read by Prof. C. N. Brown.

Mr. J. W. Stump moved that the Secretary's report be adopted.

Mr. J. M. Harper thought that since the Secretary made extensive recommendations in his report they ought to be referred to a committee to report upon. Mr. Harper then moved that the report of the Secretary be received, filed, and the suggestions therein contained be referred to a committee. This motion was offered as a substitute for the first motion. It was carried.

The Secretary mentioned the death of Dr. Edward Orton, and said that a committee should be appointed to draft resolutions of respect. The death of Mr. S. J. Baker, of Cuyahoga Falls, was also mentioned.

It was moved and seconded that a committee of three be appointed by the Chair to draw up resolutions of respect on the death of Dr. Orton. Motion carried.

It was moved and seconded that a committee of three be appointed by the Chair to draw up resolutions of respect on the death of Mr. Baker.

The Chair appointed Messrs. B. F. Bowen, A. W. Jones, and J. W. Stump.

Prof. C. N. Brown read the report of the Treasurer. It was moved and seconded that the report be received and filed. Motion carried.

The Board of Trustees was granted further time to report.

The report of the Committee on Public Highways, "A Review of the Progress in Road Building During the Last Century," was read by Mr. R. E. Kline.

It was moved and seconded that a committee of three be appointed by the Chair to formulate a resolution on the proposed bill in regard to highways, and to report at a later meeting. Motion was carried.

A paper by Mr. L. B. Harvey, of Marysville, Ohio, was read by the Secretary.

The Chair appointed the following committee to investigate the recommendations in the Secretary's report: Mr. J. M. Harper, Mr. G. A. McKay, and Mr. J. C. Cronley.

The Chair appointed the following committee to investigate Mr. Kline's proposed bill: Mr. A. W. Jones, Mr. R. E. Kline, and Mr. L. B. Fraker.

The Chair asked for volunteers for a Committee on Resolutions on the death of Mr. S. J. Baker. Committee to be appointed later.

The Chair added the names of Mr. J. M. Harper and Mr. J. B. Weddell to the Committee on Resolutions.

It was moved and seconded that the Society adjourn until evening. Motion carried.

Wednesday Evening, January 24, 1900.

The President called the Society to order in the Ohio State University Chapel, at 8:00 o'clock P. M.

A paper, "A Remedy for Bad Roads," illustrated with stereopticon, was read by Prof. Daniel B. Luten, Lafayette, Ind.

Senator Dodge, of Cuyahoga County, then addressed the Society on the subject of roads.

Thursday Morning, January 25, 1900.

President E. A. Kemmler in the chair.

The President appointed a nominating committee to suggest officers for the year, as follows: Mr. J. B. Weddell, Mr. C. M. Gordon, Mr. J. M. Harper.

The Committee on Land Surveying and Drainage was given further time to report.

Paper: "Topographical Maps for Ditch Improvements," by Mr. G. A. McKay, of Xenia, Ohio.

Mr. Kemmler gave a description of his use of the stadia method.

The Secretary read a letter from Prof. A. A. Wright, of Oberlin College.

It was moved and seconded that the Ohio Society reindorse the bill for the United States Geodetic Survey for a topographical map of the state. The motion carried.

Paper: "The Improvements of Shelby, Ohio," by Mr. J. B. Weddell.

Paper by Mr. Winslow Allderdice, of Warren, Ohio, on "The Water Supply and Purification of Water for Municipal Purposes."

The discussion of this paper was deferred until the other papers in that line were read.

It was moved and seconded that the Society adjourn until Thursday evening. Motion carried.

Thursday afternoon the members of the Society were entertained by the local committee, who had arranged various excursions to points of interest about the city.

Thursday Evening, January 25, 1900.

Society called to order by the President, Mr. E. A. Kemmler.

Paper by Prof. F. Herbert Snow, C. E., of Boston, Mass.

Paper by Mr. J. W. Stump.

Friday Morning, January 26, 1900.

Society called to order by the President, Mr. E. A. Kemmler.

Reading of the report of the committee appointed to investigate the recommendations of the chairman of the Committee on Highways with reference to the proposed legislation.

The report follows Mr. Kline's paper.

It was moved and seconded that the report be adopted. Motion carried.

It was moved and seconded that a committee of seven, including the Chair, be appointed to urge the passage of this proposed bill upon the present General Assembly. Motion carried. Chair to appoint the committee during the session.

Report of Committee on "Sanitary Engineering," by Mr. C. A. Judson, of Sandusky, Ohio. He read a paper on "The History of Water Supply."

Paper: "The Old and New System of Constructing Bridge Masonry and Their Comparative Cost," by Mr. Chas. M. Gordon, of Georgetown, Ohio.

Report of the Trustees.

It was moved and seconded that the report be received, placed on file, and the recommendations contained therein adopted. Motion carried.

ELECTION OF MEMBERS.

The Secretary read five applications for membership: John W. Groves, Art K. Demont, Chas. H. Webster, E. H. Fisher, and M. M. Gillett.

It was moved and seconded that the rules be suspended and the members be elected by acclamation. Motion carried.

The following amendment was offered to this motion: "That the Secretary cast the ballot for the Society." Carried.

It was moved and seconded that if Prof. Snow made application for membership, as expected, and his application was acted upon by the Trustees, that the Secretary cast the ballot for the Society for his election to membership. Motion carried.

UNFINISHED BUSINESS.

President Kemmler appointed on the Legislative Committee Mr. R. E. Kline, Mr. A. W. Jones, Mr. L. B. Fraker, Mr. G. A. Weddell, Mr. J. W. Stump, and Mr. E. A. Kemmler, chairman.

Mr. Pratt thanked the Society, on behalf of the students of the Ohio State University, for the pleasures and benefits derived from meeting with them.

Mr. McKay: "I desire, in behalf of the visiting Society, to offer the following resolution: I move that a vote of thanks be extended to the local engineers for the splendid way in which they have entertained us during our visit in the city, including the refreshments partaken of last evening." The motion carried.

NEW BUSINESS.

The selection of the next place of meeting.

It was moved and seconded that the Society meet in Columbus next year, from the fact that Columbus is a central point for all, and the best adapted on that account to hold our meetings. Motion carried.

ELECTION OF OFFICERS.

Report of the Nominating Committee, read by President Kemmler, was as follows: Messrs. Homer C. White, President, Warren; J. C. Cronley, Vice-President, Lima; Frederick J. Cellarius, Secretary-Treasurer, Dayton. Board of Trustees: Prof. C. N. Brown, chairman, Columbus; E. A. Kemmler, Columbus; Charles M. Gordon, Georgetown; G. A. McKay, Xenia; A. W. Jones, Chillicothe.

It was moved and seconded that the report be received, and the names nominated by the committee be elected by acclamation. Motion carried.

President Kemmler thanked the Society for the honor given him in presiding at these meetings.

It was moved and seconded that the Society adjourn. Motion carried.

PRESIDENT'S ADDRESS.

Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

When the Society assembles a year hence a new cycle of time will have been inaugurated. A century of enterprise and production, such as the world has never seen, will have closed an eventful career, which will stand forever as a glorious monument to engineering genius and skill. To use the words of Professor Thurston:

"The nineteenth century will always be remembered, however long the world may last, and whatever may prove to be its future progress in mechanics and the useful arts, as having been the century in which the long dormant genius of invention was awakened into life and full activity. This century has seen the grandest triumphs of every department of natural growth and advancement. The steam engine, little known and hardly appreciated as a possible burden bearer for the race, has come to carry the whole weight, practically, of modern civilization."

While meditating along this line it occurred to me that this occasion, the last meeting of the Engineering Society in the nineteenth century, would be a fitting one to cast a retrospective glance upon the rise and development of the engineer's art during the century with whose successes and triumphs it has been so closely identified.

Engineering, as an art, thrived among the ancients, especially the Romans and Egyptians. The irrigation works and pyramids of Egypt, and the ruins of the Roman aqueducts and roads, still remain as witnesses to this fact.

Scientific engineering, however, hardly antedates the present century. It began with the perfection of the steam engine by James Watt in 1777. The eighteenth century, however, realized few of the benefits bestowed upon the race by this invention. During the nineteenth century the steam engine has become the prime mover of the world, and now does the work of one billion laborers, or three or four times the working force of the world.

Assuming transportation facilities as the index of the state development of engineering art in the nineteenth century, we shall recognize at least four distinct periods:

1. The period of the turnpike and stage coach.
2. The period of canals and steam navigation.
3. The period of railroads and telegraphs.
4. The period of electric motors and telephones.

ROADS.

A civilized race has need of good roads first, last and all the time. Their use antedates the Christian era. Many of the Roman roads still remain in such good condition that they serve admirably as foundations for new roads. Indeed, we may almost say that there is nothing new under the sun in the line of road building, for the French, who are the modern road builders, have patterned theirs largely according to these ancient examples.

The roads of England are said to have been in an almost incredibly bad state near the close of the last century, owing to the same kind of laws which keep many of the roads of this country in such a disgraceful condition.

In 1819, Engineer Telford appeared before the parliamentary committee on highways and depicted the condition of the roads; but not until 1835, when the general highway act was passed, was anything done to relieve this condition. As a result of this act, and the judicious use made of it, the roads of England today are a credit to the country, thanks to the educational work of Telford and McAdam.

Ireland, Scotland, Germany, France, Switzerland, Austria, Belgium, Spain, and Scandanavia, all boast of excellent road systems. France easily has the most perfect system of roads, as well as road maintenance, in the world. This fact is due alone to the famous *corps de ponts* and *chaussees*, created in 1716, whose engineers have absolute control of all roads, pavements and bridges in France.

In this country a number of excellent roads were built by the government early in the century, notably the National Road from Cumberland to Wheeling, and afterwards through Ohio and Indiana. The road was completed to Wheeling in 1820, after fourteen years of labor, at a cost of $17.000,000. It was macadamized thirty-five feet wide, with grades not exceeding five degrees. It was projected as far as St. Louis, but was abandoned and turned over to the several states in 1830, on account of the rise of the railroad, after having been completed to the Indiana line. We can not but point with pride to this magnificent piece of work, and at the same time deplore the mistaken policy pursued since its construction, which assumed that the necessity of good roads has been outgrown by the advent of the railroad.

CANALS.

Canals for irrigation purposes were constructed by the Egyptians before the Christian era. Soon afterwards transportation canals were built throughout Europe. But progress in canal development seems to have stood about as still as the water in these level ditches, for not until the fourteenth century were docks used to overcome irregularities in topography.

Although the construction of many important inland canals

was undertaken in Europe during the last century, owing cheifly to the efforts of the English Engineer, Brindsley, and the French corps of bridges and roads, it has remained for the nineteenth century to complete the development, as well as to chronicle the decline of this method of transportation.

The Caledonian Canal in Scotland, suggested by James Watt, and built by Telford, was one of the earliest and most successful of these. It is 61½ miles long, and connects the North Sea with the Atlantic Ocean. It was opened in 1823.

In this country the Erie Canal, from Buffalo to Albany, was probably the most important ever constructed. It was the first avenue of communication of New England with the West. The canal was commenced in 1817 and opened in 1825.

It is needless to add that this as well as the majority of other inland canals have about outlived their usefulness. The Middlesex Canal in Massachusetts was abandoned as early as 1853 on account of loss of business to railroads.

So the Wabash and Erie Canal in northern Ohio and Indiana closed its career more than a decade ago. The loss to the State of Ohio from operating its canals in 1898 reached $100,000 in cold cash.

The canal of the future will be of the inter-oceanic type, where financial success is not the only consideration. Many of these have been under consideration and construction during the century. Chief among these may be mentioned the Manchester Canal in England; the North Sea Canal in Germany; the Corinth in Greece; the Suez Canal, connecting the Red Sea and the Mediterranean; and not the least important, the Panama and Nicaragua canals.

Of those completed and in operation the Suez Canal is unique in more than one respect: it is the only existing sea-level canal without locks at either end. It is also the only canal which commands sufficient traffic to maintain it, and that only by charging enormous tolls. In 1897 the average tariff per vessel passing through the canal was $5,000.

The Suez route reduces the distance from western Europe to India from 11,379 to 7,628 miles, or thirty-three per cent. It was commenced in 1860 and opened about 1870, costing about 22,000,000 pounds sterling.

The opening of the $33,000,000 drainage canal at Chicago on January 4th of this year was a great event in the history of that city. The sewage of Chicago now flows into the Mississippi basin, and the Chicago river is said to have already become a clear and harmless stream, while the citizens along the Illinois and Mississippi rivers, especially at St. Louis, are up in arms against the dumping of Chicago sewage into their streams.

As far as a water route from the lakes to the gulf is concerned, the matter is now, as it were, "up to the United States Government." The canal will float any boat which plies on the Missis-

sippi or the lakes, but there remains 300 miles of Illinois river to be improved, which the government will be asked to do. The money that the government is now sinking into the seven-foot barge canal from Rock Island to Hennepin would almost suffice for this improvement, which is estimated to cost $15,000,000.

STEAM NAVIGATION.

Although steam railroads were almost unknown before 1830, or fifty years after the perfection of the steam engine, navigation with steam as the motive power was proven a success by Robert Fulton as early as 1807, when, with his vessel "Clermont," fitted with one of Boulon and Watt's twenty horse-power engines, he made the first really successful voyage by steam from New York to Albany, up the Hudson. The vessel sailed 110 miles in twenty-four hours, against stream and wind.

The first transatlantic steamboat was the "Savannah," built in New York. One of its first voyages was from Savannah to Liverpool, in 1819, occupying twenty-two days.

But it was not until 1838, when the British vessels "Sirius" and "Great Northern" arrived at New York from England, that the practicability of oceanic steam navigation was fully demonstrated to the world. The "Sirius" required 17, and the "Great Northern" 15 days to make this trip.

A comparison between the first transatlantic Cunard liner, Britannia of 1840, and the Campania of 1895 will show better than words the progress made in this method of transportation during the latter half of this century:

Length, -	207 feet.	600 feet.
Displacement, -	1135 tons.	12050 tons.
Horse Power, -	740	31050
Cargo, - -	225	1620
Speed, - -	8.5 knots.	23.18 knots.
Cost, - -	$100,000	$3,550,000
Time, - -	15 days.	5 days, 8 hours.

Fulton, the father of steam navigation, was born in Britain, Pa., in 1765, and died in 1815. He was the first American Civil Engineer.

RAILROADS.

No industry has been identified so intimately with progress and advancement during this century as the railroad. There is no business which is not benefited, no inhabitant of a civilized country who is not interested, directly or indirectly, in the railroad. Indeed, it is difficult for those of us who have always been accustomed to railroads to picture any civilization at all without them.

Commencing with the historic race of Stephenson's "Rocket" on the Liverpool and Manchester Railway in 1829, it has rapidly

grown, with its allied interests, into the grandest industry of the world.

From the Stephenson locomotive, weighing four and one-half tons, capable of drawing forty tons on a level, to the modern heavy freight locomotive, weighing 116 tons, capable of pulling 2000 tons, is, indeed, a marvelous step, indicating a rate of growth unrivaled in the history of industrial affairs.

John Ericson, Stephenson's unsuccessful rival in the race of the "Rocket," has been dead only eleven years; Peter Cooper, who experimented with the first locomotive built in this country, sixteen years; Horatio Cullen, who ran the first locomotive that was used in America, eleven years. The locomotive used by Allen was built in England under his direction. The trial trip of the "Stourbridge Lion," as he called it, was made at Honesdale, Pa., on the Delaware and Hudson Canal Railroad, on August 9, 1829, the same year that the "Rocket" made the first successful trip in England.

The real pioneer of American railroads is the Baltimore and Ohio The road was built by citizens of Baltimore, principally for self-protection against the canals. This paper would be incomplete without a brief history of this enterprise.

In 1825, Baltimore, with its 70,000 population, had developed a large trade with the trans-Allegheny people, transported with wagons on fair turnpike roads, while its foreign commerce, conducted in its home-built, fast sailing vessels, known as "Baltimore Clippers," extended to all parts of the world.

The opening of the Erie Canal in 1825 caused the merchants of Baltimore much uneasiness. Competition between turnpikes and canals was hopeless, and the Chesapeake and Ohio Canal, proposed as a rival of the Erie, was found to be impracticable.

In 1827, two merchants, Philip E. Thomas and George Brown, called a meeting of the citizens "to take into consideration the best means of restoring to the city of Baltimore that portion of the western trade which has been lately diverted from it by the introduction of steam navigation and other causes."

As a result of this and a number of other meetings, the merchants of Baltimore came to the conclusion that the new method of transportation by rail, just springing into life, might be made available on a more extensive scale for connecting Baltimore with the western states. Accordingly a charter was obtained from the following legislature, under which the B. & O. Railroad was incorporated. This was the first railroad charter granted in this country, and the work was prosecuted on a much larger scale than anything promoted at that time in England.

Philip E. Thomas was the first president, and Jonathan Knight the first chief engineer. Knight was the same engineer who was engaged upon the National Road from Cumberland to Wheeling, and later on the surveys for the extension of the road through Ohio and Indiana.

The corner stone was laid on July 4, 1828, and the road opened in May, 1830. Horses were the first motive power. The first locomotive was run on August 28, 1830, by Peter Cooper.

The first railroad chartered in Ohio was the "Mad River Road," from Sandusky to Dayton. The charter was obtained in 1832. Sixteen miles of the road were opened in 1839. In 1844 it was completed to Dayton.

In 1830 there were 23 railroads in the United States; in 1840, 2,818; in 1860, 30,635; in 1880, 86,121.

The time does not permit of even mentioning any of the wonderful feats of engineering accomplished in railroad building. Let it suffice to say that the necessary adjuncts to railroads, like bridges, tunnels, terminals, loops, and switchbacks, have given the engineer great opportunities for applying his ingenuity to surmount the natural obstacles presented, and have created an army of engineers numbering in the hundreds of thousands, who would not exist but for the railroads, and without whom such feats as the Mt. Cenis, St. Gotthard, and Simplon tunnels, and the St. Louis, Niagara, and Forth bridges, would have been impossible.

In viewing it from whatever standpoint we may, the profession of civil engineering must attribute its high standing of today very largely to the railroad; for railroads have made engineers, but engineers alone can not make railroads. At any rate, history has never reported any millionaire engineers, as far as I know.

BRIDGES.

Bridges, like roads, are of ancient origin. The Romans, Greeks and Egyptians built stone arches and wooden bridges. After the Romans the art lagged until the eighteenth century, when the French corps of bridges and roads was organized.

The first wooden truss bridge was built in America in 1808 by Theodore Burr.

The first suspension bridge of note was built in 1819, across Menai Straits, by Telford. The span was 570 feet long.

The earliest example of a properly designed girder in England was the Brittannia tubular bridge, carrying the Chester and Holyhead Railway across Menai Straits. It was built by Robert Stephenson in 1845. This type was soon superseded by the open girders of the Warren and Fink types.

The first impulse to the general adoption of iron for railroad bridges was given by Benjamin H. Latrobe, the second chief engineer of the B. & O. Railroad. Albert Fink furnished the plans.

In 1851–2–3, spans up to 205 feet were constructed of cast and wrought iron across the Monongahela river.

The first scientific treatise on designing bridges was published by 'Squire Whipple in 1847. It embodied the same principles which are used today.

Steel was first used on the Eads bridge at St. Louis and the Brooklyn suspension bridge.

Cofferdams and pumps were first used in England in 1809, on the Waterloo bridge across the Thames, built by John Renne.

Pneumatic caissons were introduced in 1855. The greatest depth ever obtained with their use was on the St. Louis bridge. This famous structure was opened in 1874, and is still considered the finest example of arch in the world.

The Ohio river was first bridged in 1863, at Steubenville, with a 320-foot channel span.

The art of bridge designing has made wonderful strides during the last quarter of the century. The cantilever, camel back, steel arch, and the railroad suspension bridge are some of the magnificent types evolved during this period. Concrete, as a substitute for stone, has also taken front rank in the construction of arch bridges and culverts, as well as in other types of construction.

As it would be impossible to do justice to every branch of civil engineering in an address of this kind, a few words of "honorable mention" for the balance must suffice.

WATER WORKS.

The earliest application of steam to pumping water was made at Philadelphia in 1800. The first cast iron water pipe was laid in the same city in 1804. Sand filtration was introduced in England in 1839. Mechanical filters have been exploited during the last decade. Both methods of water purification have attained such a high state of excellence that it is now possible for almost any city to secure good drinking water, no matter how rough the raw material may be.

COMPRESSED AIR.

The practicability of compressed air to transmit power over long distances was first demonstrated by its successful use in driving the Hoosac and Mt. Cenis tunnels. The latter was opened in 1871, after fourteen years of incessant work. It opened the first railway piercing the Alps, and was accepted as one of the wonders of the world when completed.

EXPLOSIVES.

There was no explosive more powerful than gunpowder until 1832, when guncotton was invented. Nitroglycerine was invented in 1847 and dynamite in 1866.

ELECTRICITY.

Although the electrical science dates back to the studies and experiments of Benjamin Franklin in 1746, it was not until one hundred years after, when Prof. Morse introduced the telegraph,

that any practical benefit was derived from it. The first Atlantic cable was laid in 1858. The telephone followed in 1876. It was first exhibited by Mr. Bell at the Philadelphia Exposition. A few motors and dynamos were on exhibition at the same time.

In 1879 Edison invented the small incandescent lamp.

Fourteen years later, at the Chicago Exposition, almost the entire light and power was electrical.

With electric motors came the development of water power on a large scale, with turbines and Pelton wheels as the prime movers. The turbine, invented by a Frenchman—Fourneyrou—in 1833, had been used extensively for mill power previous to this time, but on an insignificant scale.

The Niagara Falls River plant of the Cataract Construction Company, the largest of these water power plants yet established, was opened on January 25, 1894. Three turbines of Swiss design, of 5,000 horse power each, or a total of 200 mill powers, had been installed at that time, while the plant is designed for an ultimate capacity of 50,000 horse power.

STEEL BUILDING CONSTRUCTION.

Skeleton construction for tall buildings was first employed in Chicago in 1883. It has since completely revolutionized this branch of architecture. The twentieth century architect, to be successful, must be not only an architect, but an engineer as well.

ENGINEERING SCHOOLS.

France had a number of engineering schools previous to the nineteenth century. The *Ecole de Ponts et Chaussees*, established in 1847, followed close upon the heels of the celebrated *Corps* of the same name.

The Polytechnic School of Paris was opened in 1799.

England lagged behind until 1840, when the first regular school, The University College of London, was opened. But this school does not seem to have become famous, for as late as 1867 the *London Engineering* remarks editorially:

"Until we have an engineering college, the course open before the young beginner can not be distinctly marked out. He may enter an office, but that will not necessarily secure his qualifications as an engineer."

At this time Germany and France had already reared a generation of educated engineers.

The first school in America was the Rensellaer School of Civil Engineering, which graduated its first class in 1826.

Now there is at least one State University in every state in the Union, and private and denominational colleges, where the various branches of engineering are taught, too numerous to mention.

ENGINEERING SOCIETIES.

I need not expatiate upon the wholesome influence of engineering societies upon the profession during the century. They originated early in the century, and have produced some of the best engineering literature in existence, to say nothing of the helpful aid given many struggling young engineers in the pursuit of their profession.

The first society of any prominence was the English Institute of Engineers, organized in 1817 and incorporated in 1828. Telford was the first president.

The American Society of Civil Engineers was incorporated in 1852.

Our own State Society has just attained its majority on this, the occasion of its twenty-first annual meeting. May it thrive as long as engineers exist, and grow in numbers and influence until it has become a power in the state, as it ought to be, second to no other organization of professional men.

ENGINEERING IN THE TWENTIETH CENTURY.

After contemplating the countless achievements of the engineers' art during the now closing century, we may well cast a speculative glance into the coming century and wonder what new methods of subjugating nature's forces the next hundred years will bring forth, or what "unfinished business" of the old century will be successfully completed in the new.

Certain it is that the opportunities before the new century for making itself famous are equally as great as those of its predecessor has been.

Though the earth has been pierced and its stored energies brought to the surface to be transformed into every conceivable form of dynamic power; though the waters have been subdued so as to afford access to almost every part of the globe; though the mystery of the subtle fluid, electricity, has been penetrated, the one great element, the atmosphere, still remains master of itself.

The success of aerial navigation, if it is accomplished during the twentieth century, will alone make that century famous; and when we think of the many seemingly impossible events which have occurred in the present century, this fact does not seem at all impossible. And it may reasonably be expected that when the members of the Ohio Society of Civil Engineers and Surveyors come to attend the one hundred and twenty-first annual meeting at the Capital City, many of them will come by the aerial route.

The general adoption of the metric system of weights and measures would be a brilliant beginning of the century.

The successful construction and opening of the Nicaragua Canal by the United States will be a twentieth century feather in the cap of our own country.

One of the greatest industrial features of the twentieth century will be the increased development of water power on grander scales than ever before. According to Mansfield Merriman, the rivers of the United States alone can furnish 200,000,000 horse power. Of these 1,500,000, or less than one per cent., are now being utilized. It seems that the time will soon come when this enormous energy capable of being stored at the headquarters of our streams, after the impounding dams have been constructed, without the lifting of a hand by man, will not longer be permitted to run to waste.

With the damming up of these streams for water supply and power purposes will come, incidentally, one great factor in the solution of the flood problem along the lower waters of the main streams. A large portion of the flood water will be held back by the reservoirs, to be released only as fast as needed, thereby reducing the height of the flood to the extent of the ratio of the unused capacity of the reservoirs at the time of the flood to the total quantity of the run-off.

The twentieth century will witness the installation of a great number of sewage purification plants. The time when legislative bodies will be compelled to shut off raw sewage from streams, whether used as water supplies or not, is not far distant.

The people of the twentieth century will likewise refuse to drink unfiltered river water. The profession of sanitary and hydraulic engineering will be in the front rank when public opinion has reached this point.

A large number of nineteenth century cities have gone headlong into the street paving business on a stupendous scale, without any well-defined plan of keeping these pavements in a decent condition of repair. The title, "permanent improvements," which has been given these pavements, seems to have created in the minds of their promoters the idea that they ought to last forever.

With a few noted exceptions, the American municipalities do not realize yet what enormous elephants they will shortly have on their hands. Let us hope that when streets are paved in the next century their future shall be clearly mapped out for at least as long a time as the life of the best material in them, and that provision will be made to keep them in good condition for the entire period of their existence before the first shovelful of dirt is moved.

What is true of city pavements is equally true of country roads. America can obtain excellent examples of how to produce and keep good roads from the European races. In addition to this, at least one worthy ally has come to the assistance of the engineer, the League of American Wheelmen, and the future may bring another, the automobile club. Under all these conditions, it will be remarkable indeed if the end of the twentieth century does not see roads in this country that will be a credit to our civilization.

From the *Engineering News* of December 5, 1895, I cite the following:

"The total value of farm products shipped in 1890 was $2,480,170,454. The haulage on this over roads was $946,414,665, which is double the total earnings of all the railroads for freight, and is largely due to the condition of the roads."

If any one thinks that the necessity of having good roads has passed, let him analyze these figures carefully before speaking. The State of Ohio would cover itself with glory by converting its antiquated canal system into a road-building and maintaining system.

Interurban electric railroads will continue to spring up as fast as the capital to build and equip them can be supplied, until every village and town of any importance will be reached by at least one of these. They will be so built that, instead of ruining the roads as many of them have done, they will help to keep the roads which they occupy in good repair, and thereby increase their usefulness.

Last, but not least, with all the good things going around, the engineer himself may not be overlooked. Perhaps we may at least hope that the profession of civil engineering will attain that standing among men which it so justly deserves.

It is immodest to glorify one's own virtues, but the Civil Engineer stands second in importance only to the clergyman and the physician. We would not dispute first place with either the preservers of our bodies or souls, but next to these, no other profession has contributed so much to civilization as the Civil Engineer.

Societies like our own will do more than any other agency to improve the standing of the profession. Good will and brotherly feeling among engineers, such as exist among the legal fraternity, will be more helpful than all the legislation which has been promoted by this Society during its existence.

Permit me to conclude with the prediction that the twentieth century Civil Engineer will perform whatever tasks are imposed upon him with the same zeal, honesty, and integrity as was characteristic of his progenitors of the nineteenth century. No duty will be too onerous for him—no responsibility too great. Capital placed at his disposal can be relied upon to be economically and judiciously expended. His reports on projects involving engineering questions and investigations will be made with the one paramount idea always in the foreground: To arrive as near the truth as possible, and to secure for his client the greatest returns for the money likely to be invested. And when the enterprise is ready to be launched into existence, and the engineer and his modest corps are again called upon to bear the whole burden and responsibility of construction and installation, he will accept the charge without hesitation. To the promoter who would enlist his aid in the conquest of new fields of activity and enterprise, he will cheerfully answer: "You push the button, we do the rest."

REPORT OF COMMITTEE ON PUBLIC HIGHWAYS.

ROBERT E. KLINE, DAYTON.

At the outset, I take it that it is the intention that this paper, in its embodiment, shall cover more especially the progress made in road building in our own state during the past century. In treating the subject at hand, it will be my purpose to deal in a general way as to methods of control of highways rather than to enter specifically into the various methods of construction that have been pursued in the past, and from the conclusions derived therefrom to deduce at least a suggestion of methods that may be adopted as a means of effecting more distinctly further progress along the line of highway construction and maintenance.

At the beginning of the century in question, the state, then in its infancy, which, although in an undeveloped condition, early gave signs of its many dormant natural resources, had no indication that it would at any time embrace the vast net-work of avenues of communication, embodying the state, county and township and other roads now marking its present map.

But few towns of any consequence were then in existence; settlements were made in small communities, and as a means of communication between the lands thus scattered, roads were marked out in many cases by mere foot-paths, later to be taken up by the communities, thereby creating a demand for a greater or less degree of skill in providing a suitable and substantial road-bed, and in some instances directing more or less attention to grades, with a view to their betterment, and to the strengthening of the road-beds at points where the same proved necessary, owing to unfavorable conditions of drainage and the swampy character of the soil in its natural condition. Such roads were, in many instances, laid out without reference to range or town lines as established by any general land surveys, the sole aim being to skirt the intervals between settlements by the shortest roads attainable. In cases, some attention was paid to attaining easy grades, and to this end roads were built over somewhat circuitous routes; but in nearly all instances the lines chosen were drawn almost exclusively to the end named in direct lines, so that such roads, if now found in existence, run at all angles across lands as a crude net-work over the entire state.

Vehicles and other conveniences adapted to travel at that time were necessarily very crude, the modes of conveyance being decidedly different from those now existing. Provisions for the

same in constructing roads were on that account not essentially so important for the same reason.

Early in the history of the state, immediately following the inception of ideas of a better means of communication in the perfecting of a system of roads, the state assumed to take in hand the granting of a number of roads, which now appear on our maps, known as state roads. Many of these were such in name only, and were never subject to extensive improvement until a later period, when taken up either by incorporated companies with charters to construct toll-pikes, or still later by municipal, township, or county authorities. State roads, as a rule, had their place, and owed their existence entirely to the end of affording a means of travel between large centers. Branching off of these, roads of less consequence were opened in many localities. These roads, radiating as arteries from the main or state roads, the more thoroughly connected the various communities. One fact that is worthy of notice, as connected with state roads as originally laid out, is that the width was, as a rule, seldom less than sixty feet. This, however, was true only in record. In the development of the same in the later construction of the road-bed proper, the ordinary width as used being no more than absolutely required for convenience of public travel, marked encroachments by adjacent property owners have since been made.

Early in the century, the commissioners of the different counties began to grant county roads, many of which were practically over precisely the same lines as laid out for state roads. The need of good roads was being felt as now, and the efforts upon the part of officials vested with power given them by the state, county, or township, with the poor result attendant upon the same, show that the fact was then true, as now, that the demand for good roads went far beyond the provision for the same in the existing laws. The fact that better roads were not constructed was not therefore entirely from the fact that there was no demand, nor again from the fact that there was insufficient skill, nor from an absence of materials, but mainly from the fact that there was, as is now, a tendency to neglect the formulating of precise methods to attain that end, even though the public sentiment demanded the same. The roads of our state have, in a great measure, been developed by a succession of unorganized efforts born in the suggestions of certain necessities, and not as a result of matured plans and specifications, with points as to the best methods of construction and with the end of securing the best results in view.

With all due respect to those who have graced their places upon official boards and in other executive offices upon whom the development of roads of various character have been dependent for attention, much can be said by way of criticism as to what has been accomplished. It is furthermore unnecessary to turn back to a period very remote to discover that while the

intention and aim has perhaps always been to secure best results along the lines indicated, the same has never in the fullest measure been attained. The blame, however, is not to be attributed, therefore, to the intention, but more to the method pursued in control as provided by law. It may be said that ordinarily ample provision has been made for the right of way for travel, and that, it seems, has been to a great extent the one important purpose of road legislation in the past. In many cases, this has not been strictly the case, but the evidence of the existence of this state of facts has to a greater or less degree marked nearly every period in the history of the development and control of the highways of the state.

Not until that period when incorporated companies, with a view to supplying suitable means of travel in more perfectly constructed roadways, known as toll-pikes, had arrived, did any system of roads constructed in the state attain any degree of perfection. These companies had the end in view of deriving sufficient income upon such investments, the same to be secured by levying toll upon all who found it necessary or otherwise convenient to use these better ways of travel. In the construction of such highways, or toll-pikes, much depended upon the natural resources of the surrounding territory as pertaining to materials used, thus regulating the state of perfection attained in the efforts put forth in this direction by such companies. The bridges constructed were built with a view to permanence, so that no greater expense than necessary would thereafter be required in their maintenance; stone culverts were no infrequent occurrence, many of which stand today as when first constructed, some of which have, however, yielded to a greater or less extent to the wear of many years. The grade, drainage, foundations, and surfaces of such roads were often made to that degree of perfection which the conditions permitted, or as the probable income to be derived by the construction of same would justify. In many cases, perhaps, two roads running in the same direction were the recipients of the efforts of two rival companies, vying with each other as to shortness of distances, grades, and manner of construction, in their efforts to secure the patronage of the traveling public. By this means, with natural facilities at hand, we have as a result a number of highways, the road-beds of which, by dint of some later attention, are as yet in a fairly good condition.

There are but few communities in the state at this stage of its development which now recognize the necessity of or even tolerate so-called toll-pikes. The period of their usefulness was when at the outset such avenues of communication were needed, and their construction was made possible in the lack of provision for the construction of such highways in the general laws of the state, yet by charter such companies were given authority to bring about in the construction of such highways what the state of progress in the localities in question demanded.

As the state has developed, and smaller subdivisions of towns and townships have become more frequent in the proper subdivision of lands with reference to section, town, and range lines, the lines of roads have become more fixed in direction. New methods in the location of roads have been installed. Nearly all of the roads named still hold their places, and we have in addition, at the hands of township and county authorities, roads termed section and half-section line roads built at nearly all points throughout the state where practicable.

Some attention has been paid in the recent past to the construction of roads by parties interested in the better improvement of lands otherwise naturally favored by topographical conditions, who have planned the construction and completion of avenues for practical uses as well as with a view to the aesthetic.

In addition to the efforts of the best engineering talent, frequently the efforts of the landscape architect have been called into exercise. This feature of development is necessarily governed very much by the occasion and conditions where the same has been called into play, so that advanced methods of highway construction are in such cases put into practice, and the best efforts of the profession have been directed to this end.

It is not my purpose to discuss further the best achievements or possibilities of further advancement in this field of highway engineering practice, but to continue exclusively with that branch of same which pertains to the ordinary and common avenues of public travel. Conditions which call for the exercise of engineering effort in the construction and maintenance of public highways differ with each other in the development of the varied resources of the state, and general business and social interests call for changes in the methods of this particular line of work.

We are brought face to face with the fact that, as the laws of the past and present have been insufficiently effectual with reference to control of state, county, and township roads, the demand for new effort is realized through petition after petition being filed with the various boards of county commissioners, made by parties in communities where improvements are found to be necessary. Immediately following the granting of such petitions and the laying out of roads under the general laws of the state, the jurisdiction is vested in a lower body—namely, the trustees of the township. This body in turn, while custodians of the roads in question and of other roads which, by virtue of their location, fall under their control, are called upon to provide all necessary improvements, and assure in the best degree the construction and maintenance of such roads, following the provisions of existing laws to secure that end.

In each township or town, road districts are created, in which supervisors are chosen, in many cases with but little attention to their qualifications, who are vested with instructions to carry on such work. A feature of the work of making improvements upon

such roads, which is, in particular, wrong, is the fact that the materials used in making such improvements are obtained at the discretion of such supervisor and disposed of in accordance with his judgment, whose ideas in many cases are very crude and impracticable. After the completion of a year's work so directed (or often misdirected), the trustees of the township are called upon to pay for such materials, and in turn render their bill, in amounts which exceed $25.00 in each road district, to the county commissioners, so that while the funds are expended for such purposes by the county commissioners, they are in no way responsible for the measure or success of the work performed. Supervisors of road districts, trustees of townships, or even commissioners of counties, under this poor method of the application of public funds for the use and purpose of the improvement and maintenance of public roads, have, of course, attained some measure of success in certain localities, but this quite often is true only in such instances where the natural conditions are themselves quite favorable. However, by these indirect methods it can be seen readily how easily possible it is that the poorest results have been realized in nearly every instance. The qualifications of the supervisor are very often insufficient; trustees of townships are in many cases incompetent, and should the commissioners of the county have the best knowledge and intentions as to methods, they have no other alternative than to offer suggestions, with no assurance that the same will be given due attention.

A feature that is, perhaps, the most objectionable in this system is, however, the practice of requiring all resident male voters within the prescribed age limit to work out the road tax, or what is commonly called "working the roads." By this system, while it would seem that all persons so engaged would be interested most in the successful operation of this method, to the end that the roads in their immediate locality might be best for their own use, the contrary as a rule is the result. There is that degree of inadvertence usually manifested in the average citizen so employed, that the method thus in vogue, to say the least, is very unsatisfactory and the results correspondingly poor. In some counties, whether by special or by general acts of the legislature, roads are placed under the direction of the county commissioners, who employ in some cases a competent engineer to direct the work in hand. By this means a more successful system with attending results is attained.

By special acts of the legislature in the case of a number of counties, toll-pikes have been bought by the county, and their maintenance and further improvement has been placed in the hands of county or township boards. Under the methods pursued by such boards with this better system of more direct control, and in some cases with an appropriation of sufficient funds by which proper improvements may be brought about, the results attained have been to a greater extent satisfactory. How-

ever, again, the law imposes another obstacle in certain cases where this system has been in vogue, by providing for the election by townships of special pike commissioners, whose duties are to exercise their judgment in the expenditure of moneys provided for the sections of pikes under their control. This, again, takes the control and the responsibility of the work in hand from the board which provides the funds. Such pike commissioners are often chosen merely with reference to local political standing and other influences. If, under the direction of the county commissioners and county surveyor, he has proven by his efforts to be competent for the work in charge, the tenure of his office in all probability will be but for a single year, so that each year the highway is at the mercy of a new and inexperienced hand, and that very often to a greater or less degree imcompetent at best. In our own county during the past few years, where we have, as compared with other highways in the state, a fairly good system of roads, there has been much complaint by parties interested in securing better roads, because of the disadvantages that crop out in the results attendant upon the methods pursued in highway maintenance. The commissioners of the county have been asked to employ methods as suggested by minds who see fit to give the subject attention, and who have called upon the commissioners to make appropriations to the end of pursuing such methods of improvement satisfactory to themselves, but the facts are, that under the laws regulating the control of our roads, it is impossible to deviate materially from the methods that are now in vogue. In other counties where the conditions are not so favorable and where roads are necessarily worse, this fact is necessarily more manifest.

With this presentation of the facts in this general manner, it is sufficient to draw the conclusion that, relative to the comparative development of the state and its abundant resources, the system now in vogue in the control and management of our system of public roads is no more nearly apace with the times than those pursued earlier in the history of the state. Thus from the facts it may be seen that there has been but little deviation in the principles and the methods pursued from those at the very outset. It is the prerogative of the engineer in general to direct public sentiment in the lines prescribed in the scope of his profession. In the direction of the management and control, in the making of improvements, and in the maintenance of public highways, it is essential that the demand for such be anticipated by the solution of all difficulties where possible, and the suggestion of the ways and means for the accomplishment of best results by the engineer, the same in some manner to be put before the public so as to assist in grasping not only what is needed, but what is needed first and most at each interval in the period of general progress. While facts have been dealt with in the treatment of this subject in but a general way, we have sufficient evidence to justify the assertion, speaking from the standpoint of

the engineer, that some action should be taken to secure a condition better than that now existing.

With these facts in mind, it will be well at this point to reiterate a portion of the paper presented by me before this Society one year ago:

It may be stated that the time is at hand—in fact, is now here—when an established and uniform system of highway control pertinent to every requirement of the day, embodied in a commission backed by state laws sufficient to cope with the powers of any state boards and commissions or corporate companies now existing, is extremely essential for purposes of further improvement, and the defense of the highway against such contending interests.

If the canal, with its limited interests of traffic as at present, is so provided, the steam railway likewise, and if the telegraph and telephone companies are permitted to operate under charters and with certain rights acquired from higher authorities than local county and municipal boards, the highway, of all interests the most general, should have a footing in the state on a par with them at least.

The purpose and realization of a systematic and effective improvement of roads in general can best be attained, therefore, by the enactment of a more comprehensive code of laws relating thereto, complete in nature, pertinent to all requirements as gleaned from past and present, and thoroughly competent to secure the successful accomplishment of all the ends that indicate their necessity.

To this end, as chairman of your Committee on Highways, I beg leave to offer the following as a proposed measure for your consideration:

A BILL

TO PROVIDE FOR THE APPOINTMENT OF A STATE HIGHWAY COMMISSION.

Be it enacted by the Seventy-fourth General Assembly of the State of Ohio, as follows:

SECTION 1. The governor shall, within thirty days after the passage of this act, appoint three competent Civil Engineers, each of whom shall be a resident of the State of Ohio, to serve as the Ohio Commission on Highways. Their terms of office shall be for two years, or for such time after making a report to the Seventy-fifth General Assembly, not later than the end of the session thereof in the year 1902, when the necessary action relative thereto shall have been taken.

SEC. 2. It shall be the duty of said commission to report to the next General Assembly of the State of Ohio concerning the condition of the roads in the state, and to draft a bill providing for the improvement of the same, and to compile statistics relating

to the public roads of counties, cities and towns, and to make such investigations relating thereto as they shall deem expedient. They shall hold at least one public meeting in each county for the open discussion of questions relating to public roads, due notice of which shall be given in the press or otherwise. They shall make a report to said General Assembly of their doings and the expenditures of their office. Their report shall be submitted to the secretary of state on or before the first Monday in January in the year 1902, to be laid before the legislature, together with a draft of the aforesaid bill and all maps, plans and statistics collected and compiled under their direction.

SEC. 3. They shall be provided with an office in the State House, or some other suitable place in the city of Columbus, Ohio, as a place of meeting, and in which the records of their office shall be kept.

SEC. 4. They shall establish rules and regulations for the conduct of business and for carrying out the provisions of this act.

SEC. 5. They shall each receive in full compensation for their services the sum of —— dollars per day for each day employed in the conduct of business in carrying out the provisions of this act, and also their traveling expenses, the same to be paid at the end of each month. They may expend annually for clerk hire and assistants and for defraying expenses incidental to and necessary for the successful performance of their duties, exclusive of office rent, —— dollars.

SEC. 6. This act shall take effect and be in force from and after its passage.

DISCUSSION.

Mr. Kline said, in addition to his paper, that the call for the proposed measure, or bill, could be seen when we consider that in almost every community the hue and cry is for better roads. If this is backed by enterprising people who have the interest of good roads at heart, and in a measure by citizens who are interested in better public highways, it will be made a law.

Mr. Weddell said that much money had been wasted in the improvement of roads. "There is much work done upon grading that might have been avoided in places where the ground was comparatively level. I have found that a great deal of money has been wasted because of the hands that the work had fallen into. People are employed without reference to their ability. I think the bill would be of great benefit if passed."

Mr. Bowen: "There is one minor point in Mr. Kline's paper I would like to ask about: what a landscape engineer would have to do with road making."

Mr. Kline replied that he simply referred to the work of the landscape engineer as a help in the laying out of land and beautifying it. "It is true that a great deal of capital is being invested in beautifying the adjacent parts of cities, parks, etc."

Mr. Cronley: "I think for a number of years we have not had efficient methods of road building, not only in Ohio, but in many other states in the Union. We will not have until we take the matter of road building out of the hands of the county commissioners and trustees. There are a few counties in the State of Ohio where the County Engineer has absolute control as to the method of road construction, but the great majority of the counties throughout the Union are at the mercy of the county commissioners and trustees. In Putnam County, the trustees are in debt over half a million for building roads; it has been in the hands of the county commissioners. The system in our county (Allen) is vicious, but it is a blessing as compared with the methods used by trustees in some other counties. I want to say that a dog in Switzerland can haul a bigger load over the roads there than a horse can over our ordinary country roads. As to the best method of keeping up the roads, my idea is for the commissioners to have stone distributed along the road, and have a superintendent for every two or three miles, and have the superintendent take care of his own personal road. He should have a man with pick and shovel to pick off the surplus, fill the hole, and roll that all even, then we would have a good job of repairing."

Mr. Harper: "We can discuss methods and plans until we are old and gray-headed, and be of very little benefit unless there is some action taken that will bring matters to a focus. It seems to me that Mr. Kline has submitted something here that will probably present something definite upon the subject by the time the next legislature meets. I would think it would be well for this Society to act upon that and endorse it, but if it is thought best, let it go over until later in the meeting."

Mr. Bowen: "Going back to the early days of road construction in this country, I believe that the engineer was just as competent then as today, both as to grading and general construction; especially the masonry, bridges, etc., were as complete jobs as can be done even in the present day. The only difference is the quality of the material. They did the best they could, and the work was as nearly perfect as it could be made. Many of them stand today as a monument of the excellency of the work done then. The roads were always kept repaired, and that seems to be the secret of all good roads. All roads not kept in repair soon go by the board, like all things. They had a regular system of repairing, as Mr. Kline asserts in his paper, by dividing the road into sections and having a man to keep it in repair. One of the principal things done was to keep the roads perfectly clean. So it is with all methods wherever they take interest enough to keep it in repair; where they don't, it naturally goes by the board. Men who have had an opportunity to observe these things will realize the fact that the difference of construction and maintenance of roads that I referred to was done entirely outside of the control of the county. This kind of road was constructed by the

government, and had government supervisors for its construction, and later on had state supervision. We have none of this in our modern times; it is governed by county commissioners and county trustees very little fitted for the place. Even with the present method, under the present law, we can all see that road making has made some progress. Those having construction of roads in hand can do now what men could not do fifteen or twenty years ago. From the character and the general construction of the work they have, they can persuade county commissioners to do better work than they did. The public is better educated today than it was fifteen or twenty years ago. Mr. Kline's suggestion is in line with the progress of road making. That is one of the things that ought to be well considered, and then put before the legislature and passed for law. It is one of the things to educate the people, and until that is done, we can't do very much."

Mr. McKay: "In our county, where new roads are constructed, there seems to be no provision for taking care of those roads until they become solid by wear, or are completed so as to stay in their place, and in many instances the roads are practically ruined before they receive any care whatever, and are never what they ought to be, if they were taken care of for at least one year after they are constructed. It is useless expense to spend large sums and then let the road go to pieces for want of attention. On a limestone road, built on the side of the road and well traveled, the wheels will make what we call a wheel rut—the stones and dirt fall out. Now, I have never seen, where they have taken the stone that has fallen out and raked it into this wheel rut, but that they have a good road. I have always felt it the thing to do. You will save the material that was used in that place, and you have a good road that will remain so. Where you put the stone along the road to fill in the spaces, after two or three years, I have always looked upon that as a great waste at least. I have advised the former plan in a number of cases. All they have to do is to go along and fill the ruts, then they have a good smooth road."

Mr. Fraker: "About the maintenance of roads, if the contract requires the contractor to keep the roads in repair for the first year, it assists in the maintenance of roads, if the contractor will contract to keep it in repair, for one year after the completion of the road. He will generally do this for a little more than for what he will construct the road."

REPORT.

We, your committee appointed to consider the recommendations made by the chairman of the Committee on Highways, with reference to proposed legislation, beg leave to report as follows:

After a careful consideration of the points as embodied in the report, and a further consideration of the senate bill pertaining to road improvements and introduced by Senator Dodge, the following proposed bill was drawn:

A BILL

TO PROVIDE FOR THE IMPROVEMENT OF THE PUBLIC HIGHWAYS OF THE STATE OF OHIO.

Be it enacted by the General Assembly of the State of Ohio:

SECTION 1. That within thirty days after the passage of this act, the governor, by and with the advice and consent of the senate, shall appoint three suitable persons, at least two of whom shall be competent civil engineers, and all residents of the State of Ohio, to be known as the "State Highway Commission." Before entering upon the duties of such office, each such commissioner shall file with the secretary of state his constitutional oath of office, and shall file with the auditor of state a bond, with sufficient sureties, in the penal sum of six thousand dollars, for the faithful discharge of his official duties. The terms of office of the three highway commissioners first appointed shall be three, four, and five years respectively, as the governor shall designate at the time of appointment; provided, however, that each such commissioner shall continue in office until his successor shall have been appointed and duly qualified. The term of office for each highway commissioner thereafter appointed shall be five years, except in case where appointment is made to fill vacancy during an unexpired term. A highway commissioner may, at any time, be removed by the governor for sufficient cause. Each highway commissioner shall receive for his service an annual salary of two thousand five hundred dollars, payable in equal monthly installments, and his necessary traveling expenses; and such highway commission may expend, annually, for work, hire, engineering, maps, and other expense necessary and incidental to their office, a sum not exceeding six thousand dollars, the foregoing to be paid out of the state treasury on warrants of the auditor of the state. They shall be provided by the proper authorities with suitable offices in the city of Columbus, in which all their official records shall be kept, and such records shall be and remain the property of the state, and shall be open for inspection and examination. The said commissioners shall establish such rules and regulations for the conduct of their office as the requirements of their duties may seem to demand.

SEC. 2. The State Highway Commission shall hold in each year at least one public meeting in each county, and shall cause due notice of such meeting to be given. They shall compile statistics relative to the public highways throughout the state, and shall collect such information in regard thereto as they may deem expedient. They shall investigate and determine upon various methods of road construction adapted to different sections of the state, and as to the best methods of control and the construction and maintenance of roads.

SEC. 3. It shall be the duty of the State Highway Commis-

sion during the years 1900 and 1901 to formulate an adequate system of road construction and maintenance adapted to the different conditions found in the various parts of the state, and to report to the Seventy-fifth General Assembly all statistics and information collected, with recommendations as to laws necessary to establish said system of road construction and maintenance, and for the repeal of all unnecessary or conflicting road laws.

SEC. 4. The State Highway Commission shall report biennially thereafter to the legislature concerning all the work performed by them, together with such recommendations upon the subject of highway construction and maintenance as to them shall seem appropriate.

SEC. 5. This act shall take effect and be in force on and after its passage.

The bill, as proposed by Senator Dodge, provides for the appointment of such commission and the making of appropriation at once without first laying the foundation and devising plans. The method, as proposed by this bill, provides for an interval of two years of investigation and a thorough study of the subject in all its phases, followed by a report to the next General Assembly, after which the commission will proceed in accordance with the determination of the legislature with reference to the report made.

After canvassing the sentiments of a number of Senators and members of the House of Representatives, we find that the bill, as drawn, meets with general approval.

Senator Dodge has agreed to introduce this bill today, by request, together with the bill introduced by himself, both to be brought before the committee and considered at the same time.

The first meeting of the Senate Committee to consider the subject in hand will be Wednesday evening, January 31st.

We recommend that the Society take action in the endorsement of this proposed measure.

(Signed) A. W. JONES.
L. B. FRAKER.
ROBERT E. KLINE.

A REMEDY FOR BAD ROADS.

By Prof. Daniel B. Luten.

When we consider that for upwards of forty years the farmers of this country have been struggling with the road problem; that for the past ten or fifteen years an energetic body of wheelmen has been clamoring for a solution; that county surveyors and engineers have lent their aid to the solving of the problem, and that in spite of all their efforts, not one per cent. of the roads of this country can be called good roads, we realize at once that the task is not one to be accomplished by untrained hands, but that it will require expert skill of a high order.

The problem depends in every case upon local conditions. The macadamized road, which, in the moist climate of France, is an ideal road, becomes a dusty nuisance in the dryer climate of Northern Italy. No universal solution is to be found. Different kinds of roads and a different method of caring for them will be required for each and every state of the Union, if the solution is to be the most economical one. The United States is even more peculiarly situated in this respect than the continent of Europe. England, France, Germany, and Switzerland have suitable stone for macadam-roads within easy reach. The population is congested, the country rich. In the United States, our Eastern States approximate more nearly to that condition; the most of them have unlimited supplies of good stone for roads, and the inhabitants are numerous and well-to-do. For such a section, stone roads offer a solution.

In the Central States, including Ohio and Indiana, good stone is not easily obtained. Limestone, a most inferior stone for road building, may be had; but gravel of good quality is almost everywhere obtainable. In Illinois, no road material of any kind is obtainable, except brick. Illinois may be compelled in time to follow the example of Holland, in manufacturing its clay into bricks, and thus build roads without expensive importation of road materials. But it must not be forgotten that such a method is exorbitantly expensive; nor is it to be imagined that the brick roads of Holland are ideal. They are cheaply constructed, are soon full of chuck-holes, and are really inferior to the sand and gravel roads of that country, although, of course, subjected to far greater traffic.

Perhaps, a solution for such states as Illinois, applicable, however, to the level portions only, would be the steel tramway. I say applicable to level roads only, because the principal advantage of the steel road is in the increase of load permitted; and where grades occur, this advantage is annulled to such an extent

as to make the road too expensive to be compensated by the benefits received. For a large part of our country, the dirt road must continue to be the only solution of the difficulty.

It is for this reason that I urge the necessity of local experts; not government experts, not engineers, but practical men of experience, who will be able to meet the conditions that affect the roads of their locality. At the present time very little of this expert talent exists. Engineers are employed only in constructing, very rarely in maintaining, roads; and engineers and others are too apt to forget that proper maintenance is more essential to a good system of roads than is good construction.

The state government of Rhode Island has been building stone roads in half-mile lengths, as samples of good roads, to induce the farmers to petition for such roads. They are made by approved methods, and are well-constructed stone roads. The cost of some of them is quoted from the commissioner's report:

Bristol sample half-mile, 3,095 tons of stone, $5,262; incidentals, grading, etc., $3,336, making a total of $8,598, or at the rate of $17,196 per mile.

Portsmouth sample half-mile, 2,561 tons of stone, $6,126, and a total of $14,358 per mile.

Barrington sample half-mile, at $9,826 per mile.

Scituate sample half-mile, at $15,766 per mile.

Johnson sample half-mile, at $19,028 per mile.

District of Narragansett sample half-mile (shown on the screen), at $12,212 per mile.

These roads are fifteen feet wide, and are macadamized to a depth of eight inches.

Stone roads in Rhode Island are built by state aid, a part of the expense being paid out of the state treasury, the balance coming from the residents along the road. Even with this arrangement, such a price is prohibitive, and roads built at one-tenth of that cost would still be too expensive for many localities. I am a firm believer in state aid; it compels the resident of the city to help pay for the roads of the county, and this is just, for the cities are benefited by good country roads. On the other hand, the residents of the country are not materially benefited by good streets; so that the citizen has no right to invoke state aid for street improvements. But state aid means state control, and before the farmers will trust the roads in the hands of the state, they must have better evidence of the ability of engineers to handle them economically. At the present time, the farmers of our Western States view with distrust an engineer who favors stone roads.

At Quincy, Illinois, the past year, when the Good Roads and Public Improvements Association of Illinois and Missouri had called a good roads convention, the farmers held an anti-hard roads meeting in advance of the other (and that, too, in a locality producing roads of the kind shown on the screen). The farmer

members of our State Legislature are almost always opposed to state aid. The trouble is not with the farmers; it is with those enthusiasts who attempt to force an expensive experiment upon the farmers, without satisfactory proof that it will be an economic success. Engineers are too apt to act on the principle that whatever is worth doing at all is worth doing well, but applying it only to the construction, and then leaving the road to care for itself.

I am not opposing stone roads when properly constructed and maintained. From a theoretical analysis, it can be proved that a properly maintained stone road is desirable even for light traffic. As an example, let us assume a mile of stone road to cost what would be an average value, $5,000. If the road is to be economically successful, this $5,000 will be considered as a business investment that will pay dividends. The road must be so cared for that there will be no unnecessary depreciation in value. The road, once constructed, is not to be left to take care of itself for four or five years, at the end of which time it would require complete renewal, at a cost of $4,000 or $5,000, besides having been in bad condition for a year or two. Such carelessness would involve a loss of upwards of a thousand dollars per year of the investment.

The road must be so cared for that the original investment may be considered as a permanent investment; its annual expense will then be the interest on the $5,000 at five per cent., plus the cost of maintenance, plus the deterioration in value. The interest would amount to $250 per year; the cost of proper maintenance of one mile of stone road would be not less than $200. In ten years the road would require resurfacing, at a possible expense of $2,000. Distributed over ten years and discounted for the average time would give $160, or a total annual expense of $250 plus $200 plus $160, amounting to $610 per year.

A team and driver, worth $2.50 a day, can move, on an average dirt road, one ton fifteen miles, and return without load, in ten hours. This is at the rate of 16⅔ cents per ton per mile. On a good stone road, three tons may be drawn with the same ease as one ton on a dirt road, making the cost for stone roads 5⅓ cents per ton per mile, or a saving of 11⅓ cents per ton per mile in favor of stone. If we divide the annual cost of $610 by the saving per ton per mile, we find that there would be required a traffic of 5,400 tons per year over this road to create a saving equal to the annual cost. This is on the assumption that the dirt road costs nothing for construction or maintenance. Five thousand four hundred tons per year means but five teams each way per day, provided each and every one of them is fully loaded with three tons each, where formerly the load would have been one ton. Five heavily loaded teams per day is by no means unusual on most of our country roads; nevertheless, such reasoning does not appeal to the individual farmer, who has to bear the brunt of the

expense for the benefit of the commonwealth. It does appeal to the legislator, and it is a strong argument for compelling the people at large to bear most of the expense of road building. We may hope for much from state aid, but not until the people have been educated to know the financial value of good hard roads, and that is a long, slow, and toilsome operation, and I do not believe that it is accomplished by the construction of expensive sample half-miles. In short, the whole idea of sample roads is wrong; it calls particular attention to the method of construction, but does not necessarily develop a system of maintenance, and without the proper maintenance, the stone road will by no means give the satisfaction that the well-kept sample half-mile would lead one to expect. If one wishes to see sample stone roads under existing conditions, he need only go to any of the smaller towns of the middle west, where he will find macadamized streets, built at an expense of $10,000 and upwards, and which, under better maintenance conditions than exist in our country roads, are muddy and dusty; in short, are not good roads.

We have examples in this country of all kinds of roads: the corduroy, built of logs laid crosswise, and especially serviceable where water may enter the road from below; the plank road, a slight improvement upon the corduroy; dirt roads, in dry weather, smooth, hard, and serviceable; in wet weather, absorbing water and developing ruts and mud-holes until they are well-nigh impassable; gravel roads, good for six months of the year; for the other six, broken up by heavy frosts, soaked by surface water which can not escape, or covered with gravel hub deep for repairs.

We have bad roads that have been made good by surfacing with stone, and we have stone roads that were once in excellent condition, but through neglect and heavy concentrated traffic, have been transformed into worse than dirt roads.

In Illinois, we have steel roads and brick roads, two or three miles of each. Not any one of them is suited to all conditions and localities; none of them are to be discarded as entirely useless; each and every one of them is useful and economical in some locality. And most important of all, not one of them is permanent.

You have doubtless heard such an argument as the following: Statistics show that the Central States are paying an average of fifty dollars per mile per year for repairs to our dirt roads, yet they grow no better. This has been going on for forty years. Forty times fifty, plus the interest for the average time, makes the amount of this expenditure up to the present equal to $4,000 per mile. If this sum had only been saved until the present time, it would have been sufficient to macadamize every mile of road in the country.

Such a line of argument neglects two facts: that the fifty dollars per mile, while it has not made the roads better, has pre-

vented them from growing worse; and that while a large part of that sum has undoubtedly been wasted, it would be as nothing to the waste that would ensue if all our roads were to be macadamized without first providing adequate means for caring for them.

Examining the question from the standpoint of the road surface proper, we find that roads suffer from the following defects: Ruts, due to concentration of traffic; chuck-holes, caused by the pounding of wheels into slight depressions softened by water; soft surface, from absorption of water always; dustiness, from lack of water; and bad location. These defects are, of course, at their worst in the dirt road, because it has the softest surface, but they are common to all except the steel tramway. One exception is dustiness, which, in dry seasons, will be worse on macadam roads than on dirt roads.

The remedies for ruts are a surface of harder material; or diverting traffic from a single line of travel; or the use of long whiffletrees, such that wheels follow the track of the horse; or wide tires on all vehicles. But probably the simplest and most efficient remedy is to fill them up, either with earth or with harder road metal, as soon as they begin to form, and before surface water can penetrate. Chuck-holes should be remedied in the same way. A soft road surface, except in the case of a sand road, is always caused by water. The remedy is to remove the water promptly, not by underdrainage, but by keeping the road surface free from ruts and smooth, so that the water will discharge at once into the side ditches. Underdrainage is very appropriate in cases where water seeps into a road from below, but such cases are comparatively rare, and for removing the surface water the underdrain is too slow.

If the imperviousness of the road surface can be increased, the task of removing surface water will be easier. Stone-road surfaces are impervious; gravel well compacted is nearly so; saturating dirt roads with oil is partially successful, but costly. The views show a dirt road in Iowa before and after sprinkling with crude petroleum oil; muddiness and dustiness were decreased, but the expense of such treatment amounts to upwards of one hundred dollars per mile annually. It is, however, being used to some extent on California roads to prevent dust.

The best remedy for dustiness on any kind of road is an occasional sprinkling. Means for preventing mud will also, to some extent, prevent the dust. One of the best methods of allaying the dust nuisance is by the planting of numerous shade trees along the roadside. It takes time, but the growth of our road system will be slow in all its features.

Bad location is not easily remedied; it is unfortunate that our roads should have been laid out on section lines. The remedy, however, is not, in general, by grading down hills, but by relocating the road in a curving line to lessen the grades. Notice

that nearly all the serious defects of road surfaces may be remedied in one of two ways: by using harder road material, or by employing some one to attend to the road surface at all times. The most satisfactory solution is a combination of the two; the next best solution is the attendant alone, and the most unsatisfactory is the harder road without the attendant.

The most perfect system of roads in the world is that of France. Its essential features are: First, stone roads; second, engineering superintendence; third, a constant attendant for each three or four miles of road. Neither of the first two can give satisfactory results without the last. The last *can* give satisfactory results without the others. It is, in fact, the essential basis of the whole system.

The French system was not a slow development, but was forced by Emperor Napoleon upon his unwilling subjects. The people soon learned to appreciate its value, however, in spite of its expense.

To introduce such a system in the United States will require years of education, years of agitation and legislation. The better way is to attempt to grow into a similar system in a natural manner, adopting first that which is most essential and at the same time the easiest to obtain. Railways and railway systems have not been built in a day. They are natural developments, a cheap line being first constructed, and gradually perfected by expert attendants, as traffic requires. It would be folly for a railroad company to build a well-appointed road and then leave it to take care of itself. It would be even more foolish for us to build good roads, trusting that the necessity for maintenance would afterwards develop a satisfactory system of maintenance. We have shown that we can not take care of poor roads; why should we then be entrusted with good ones?

Suppose that we could arrange all the roads of our state in sections of ten or fifteen miles each, making the sections as compact as possible, and assigning to each about the same amount of main roads; and then employ a man and team, at an expense of about four hundred dollars a year, to devote his entire time and attention to that section; to be on the road ten hours a day, rain or shine, but to be most attentive in wet weather; to be liable to discharge for laziness or lack of attention to duty, but to understand that his position was permanent during good behavior. In a short time he would become a road expert, and one of the most valuable kind, a man trained by experience on the special problem in hand; but at the same time, so inexpensive an expert that we could afford to retain him on a meager and undeveloped enterprise such as is our road system. Ruts he could fill with new and harder material, or with the aid of a grader, could smooth them down; lacking a grader, he could make for himself a drag of plank, such as is used on race courses; or even a wagon tire, heavily weighted, could be dragged along on its side

by an attached chain. Chuck-holes should be filled at their first appearance. Such repairs should never be made in wagon-load lots, but a little at a time, and with the proper quality of material, which only such an expert would learn to recognize. The surface should be kept well crowned and smooth by frequent scraping; puddles of water should be promptly drained to the side ditches, and the side ditches themselves kept clean and of proper depth and grade to dispose of the water and prevent it from penetrating to the foundation. Dusty roads should be sprinkled; shade trees should be planted along the roadside.

None of these repairs and improvements require engineering skill. That such a system would in time develop into a system requiring the highest engineering skill is not to be doubted, and by that time our farmers will be willing and ready to pay for it, which they are not at the present time.

You will find, if you investigate, that the stone road meets with but small favor among farmers at the present time. Put yourself in his place: buy a farm, and before you have paid off the mortgage, have one of your neighbors, with more money and less frontage than yourself, begin to agitate for a stone road that will cost you four or five hundred dollars; you would oppose it too. But ask the intelligent farmers of a district what is the matter with their roads, and each one will tell you that if he could spare the time from his farm, he could keep the road in good condition, and that, too, with almost no expense for materials or tools; but he is too busy, and it is not his business anyhow.

Two objections will be made to a constant attendant system of maintenance in our Central States: lack of superintendence and expense. The superintending of the attendants could be accomplished by the same officers that at the present time superintend the working out of the road tax. The attendant should be held responsible to the county commissioner, the township supervisor, or whatever officer happens, in that particular form of local government, to have control of the roads. But the superintendent would now have a decided advantage; every farmer in the section now becomes in part the employer of that attendant. Instead of shirking his road taxes, he will help the superintendent to exact proper attention from his employe, the road attendant. Failure to attend to duty will be noticed by every farmer on the road, and he will be called to order, or the superintendent notified. As the political influence of such an attendant can not be great, the supervisor would not be apt to discharge him without due cause; the attendant would come to feel that his livelihood depended upon his section, and would take as much pride in improving and beautifying it as he would in improving his farm, were he the owner of a farm instead.

The expense of such a system may be made as small as desired, the benefits, of course, decreasing with the expense. The

saving in gravel, or stone, or wasted day labor, on twenty miles of road would pay the salary of such an attendant. The greater part of the expense of repairs on all roads is labor in hauling material, not the cost of the material itself. This labor is usually purchased at retail, employing several men and teams for a few days each. Why not buy it at wholesale by hiring one man for the entire year at a much lower rate? Man and team can be hired by the day for $2.50; by the year, at the rate of $1.50 per day, a decrease of 40 per cent.

When road taxes are paid in day labor, agitation among the individual farmers will usually produce the desired result. Fifty farmers, residing upon fifteen miles of road, would not require much urging to be induced to sign a paper agreeing to pay their road taxes in cash, provided the road supervisor would agree to devote the sum to the hiring of an attendant for the section. Such an arrangement would, in some cases, interfere with the letter of the state laws; but if the sentiment among the residents of the section was unanimous for such an experiment, no trouble would ensue.

The advantages of this plan of constant attention may be summarized as follows:

1. The training of local road experts by actual experience.
2. A decrease in the number of votes commanded by patronage of county officers.
3. Repairs when needed instead of at infrequent intervals.
4. The use of proper road materials instead of the present careless selection.
5. A responsible person to whom to report defects.
6. The purchase of labor at wholesale instead of retail.
7. A rational method of beautifying the roadway.
8. A gradual evolution to a system of hard roads, together with the ability to care for them, and a growing realization by the public of their value.

DISCUSSION.

Mr. Sherman: I want to ask Mr. Luten about the use of oil. What is the necessity of it?

Mr. Luten: Those experiments were made by a professor in Iowa, and in his report on the subject he stated that the method was successful, both for dust and mud. There were several objections to it, however: the disagreeable odor, the cost, and a third was the effect of the oil on bicycle tires. Undoubtedly that could be remedied, but the expense probably could not be diminished, because the oil was obtained at the cheapest rate.

SENATOR DODGE'S REMARKS.

MR. PRESIDENT, LADIES AND GENTLEMEN: I hardly expected to take part in the discussion tonight, though I had thought to meet sometime tomorrow or tomorrow evening with the members of the Society and deliberate with them upon these questions. I am always glad, however, to say something upon this very important matter. The real importance and the very great extent of the subject is brought out by one statement made by the lecturer, to the effect that only one per cent. of all the roads in the United States can be considered good, ninety-nine per cent. being poor or unimproved. Now think of that; then add to that thought the other one that he brought out, the repairing of those roads, showing that $5,000 for half a mile is the cost, or $10,000 per mile. Now, when you consider that the number of miles of roads in the State of Ohio is about eighty thousand, or a distance equal to more than three times around the globe, then multiply that by the number of states in the Union, then consider that ninety-nine per cent. of these roads are in an undeveloped condition, then consider that it would take possibly $5,000 per half mile to improve them, and you will see that millions and millions of dollars are required —a fabulous sum.

I remember that when Mr. Flower was Governor of New York he wrote an article in the *North American Review* on the subject of the improvements of roads. He said it would take as large an amount of money to improve the roads of New York State as it took to carry on the war of the rebellion.

I don't know how the lecturer arrived at the conclusion that $5,000 would be sufficient to improve a mile of road, when all reports and all experiments show that it costs $5,000 for half a mile instead of $5,000 for a mile,—that is to say, if you have a good, hard, wide, durable road.

What I think and have said before is that these experiments which are intended to show what ought to be done are the very things that show we can not do it. We can improve the state in some manner, but as soon as you attempt to extend the improvements over the country it reaches into a fabulous sum. The farmers are unwilling to assume such a very great burden, and especially when there has been a great decrease in the agricultural industry.

The question is, what should we recommend, what should we undertake to do?

I will say again that I long ago found out what the great cost was, and when I was one of the Road Committee, in 1893, I reported some of these facts, showing the very great expense that is brought out by every experiment.

And there is another question that you run up against.

Even if you can surmount these difficulties which I have explained from time to time, even if you can surmount all of these difficulties, there would yet remain this proposition, as to whether you could maintain a certain system of construction in competition with other means which certainly exist in the realm of possibility.

Viewing the great future upon one side and the great possibility of new development upon the other, I have considerable doubt as to what method should be assumed by the state, but I have been very hopeful, indeed, that we should see a very excellent way devised for any country. I know that the minds of most people are set upon copying the methods existing in the older countries, the older methods. They are looking backward. They think that the only thing we can do is to repeat what has been done by other countries. I do not think that we are bound to imitate the example of other countries to the full extent. I do not believe that we should. I think our country, so great as it is, will be able to introduce better methods and better roads, and yet by cheaper means. But to have the ideal system of stone roads upon all of our highways is not at all in sight. No one living could hope to see that carried out. But, on the other hand, there is great hope in obtaining another material for the road-bed.

Some of the engineers have heard me speak frequently about the steel roadways, so I shall not take any time to get into that matter, but will make a suggestion or two along another line supplementary. I only desire to say here that I do not want to be understood to be preaching any particular method of improvement. It is known by many that I have recommended the steel roads, but I also recommend other methods and think we ought to hold fast to everything that is useful, whatever may be the material used or the method employed.

Now, you will remember that in the pictures here there was one showing a dirt road which had been treated with oil, which showed a great improvement, at a cost of $100 per mile per year.

I have noticed, and I think, perhaps, others have, that where bicycles go frequently, more frequently than other vehicles with iron tires, that the roads are smoother and freer from dust, showing that those places where the rubber-tired vehicles go with great frequency will remain freer from dust in a dry time and freer from mud in a wet time which is not too wet. I have taken notice that without labor and without preparation there has been made a smooth pathway by the passing of these rubber-tired vehicles over the earth. Now, that has made me believe that with the introduction of the automobile, dispensing with the iron and using the rubber tires, and the roads prepared so as to shed the water before it has time to injure the road-bed, I believe that you will have roadways that will be permanent at about one-fifth of the cost now required for power. If I should be mistaken, I will simply say that the treatment of oil ought to help it very greatly at an

expense of $100 per mile per annum. If the roadway is narrow, the expense would be diminished. Our progress along that line would be much faster than an attempt to build too costly roads of stone.

I think I see something that is capable of development. I think that it is possible to introduce new methods and, I may say, new vehicles, and upon that point I desire to make this remark, that practically all the vehicles you ever see carrying burdens are always as heavy as the burdens they carry and some of them many times heavier, so that there is the cost of carrying the dead weight equal to the cost of carrying the live weight. I think that is an error that can be overcome. The first success in that direction is represented by the bicycle. There is a vehicle which carries ten times its own weight. If the vehicle weighed as much as the burden it carried, its usefulness would be gone. None of us could use a machine that was equal to our own weight. It seems to me that the bicycle has fully doubled the power of every young, active person for locomotion. When we double the power for that, we double the capacity for many other things, which I will not go into. I look upon the bicycle as a thing which adds wonderfully to the power of the human being. The increased capacity for producing power is always doubled when you double the power of locomotion. Now, I think that is the true line upon which to work, the economical line upon which to work. I am very hopeful in that direction, and I want to say to you engineers, and especially to the young men of the university, as I take it some of these are, that there is a great field to enter there with almost a certainty of great success, and you may say that the laborers are few but the harvest is great.

I could not, without some illustrations, which I have no means of producing, give you any more definite idea of what I have in mind in reference to these great changes. It seems to me as if it were hard to move along the old line while I see along the new line every possibility of success. By way of illustration, let me say so long as we have depended upon animal power for transportation the improvement has been very little, very slight, very slow. Where we have been able to substitute inanimate power, either upon land or water, the improvement has been greater. The power of electricity has far exceeded the expectations of the most sanguine. But all the improvements in our transportation by animal power has been very slight indeed.

I note that the lecturer gave an example of how a person could go fifteen miles with a load and return with another load, at a cost of sixteen cents per ton per mile. Let me say to you that if he had to go the fifteen miles with his load and return empty, which is more likely the case, it might be. It is not to be supposed that the sixteen cents per ton per mile is the cost of transportation by animal power. The cost is much greater.

In 1893, I had the honor to submit the report of the cost of

transportation to the Governor of Ohio, the present President of the United States. We estimated as nearly as we could obtain the facts. We figured it at twenty-five cents per ton per mile, for short and long hauls, good and bad roads. I guess it would cost five dollars per ton to go over some of these roads displayed in the pictures. The correctness of the estimates at that time was doubted by many, but it was a source of great gratification to find out later, in 1896, that the Government of the United States had undertaken to make experiments or tests to ascertain facts from those engaged in the transportation business, and the result of the report in 1896 showed that the cost for the eastern states was thirty-two cents, for the southern states twenty-eight cents, for the middle states twenty-five cents, for the northern states thirty-two cents. I will not undertake to give the figures exactly, but I do remember very distinctly that when it was averaged at twenty-five cents it was very gratifying to me, because I had estimated it at twenty-five cents and had presented it three years before.

If you will examine the statistics, you will find that animal power is very much higher. It remains high; you can never reduce it to a very low rate.

I believe the best theory is to use the electric railroad system in cities and for the long hauls upon the country roads, and leave the short hauls to animal power and the best roads that we can make, until such time as we may be able to practically substitute lighter vehicles; but I almost expect to see the time when the whole matter of transportation by animal power will be a thing of the past.

Let me say this, that I have been fully justified in all claims made as to the economic gain, though I have been disappointed in the public spirit. I think that the people are not yet up to the point where they are willing to take hold of the improvement. As a result, the more enterprising few are the ones that are reaping the greatest benefit out of the new substitute for animal power; but it is yet in its infancy. If we can diminish the cost of construction and increase the power of the government that we may call upon for assistance, we may bring these two extremes together, but as long as the power is weak and those who carry the burden are few, we can make but little headway. If we can devise cheaper means and better results, and call the state to our aid, then we shall make great progress.

It was the custom of the state to maintain state roads, but absolutely all is gone except the name; it has proved unsuccessful. The United States built the National Road. That has been abandoned; nothing of that remains, practically, but its name; so that the State of Ohio and nearly all the other states of the United States, also, have turned their backs upon this great enterprise. The reason why that was so is because, with the entrance of other power than animal power, the long hauls were taken care of, and the excessive cost by animal power made it impracticable

to move anything by that power. The government turned it over to the local authorities, and there it rests; and there it will rest unless we shall revive the law and interest of the people, so as to call forth that aid again which was once given.

I believe that if the farmers and the bicycle riders would unite in a strong call upon the government of the state to give that aid which it once gave, that the call would be answered. I also believe that the general government itself, which I had the honor to represent, if it were called upon, would also yield some support. I see no reason why the same interests that built the National Road might not be locally and generally revived again in this new condition.

I am pleased to note, too, that some person, a member of the House of Representatives at Washington, has lately entered a bill providing for an appropriation of five million dollars by the general government for road improvements. I am not expecting that bill to become a law; it is the first time in nearly two generations that anything of this kind has been proposed. It shows that we are growing along that line, and why should not the government of the United States do as much for the transportation over land as over water? They put thousands and thousands of dollars into improving water transportation, a portion of which, I think, we all understand is misspent and misplaced, because it is given with the view of deepening water in shallow streams. When we spend such sums to deepen the water in channels and rivers where the transportation could never be made cheap, there is an error, there is a misdirected application of national revenue, and if a call is made and pushed generally by the people, it will, I believe, result in an appropriation of as much money as is spent in the river and harbor bill to aid in transportation over land.

I also note that Julian Hawthorn has proposed a National Boulevard, 250 feet wide, to be built by the National Government from ocean to ocean. He says that the American people do not know their own country; they travel in fast-running cars much of the time, and they do not think about the country they are passing over. He thinks that if such a thing as he suggests were to be built, so that bicyclists, carriage drivers, automobilists, and even pedestrians, could go at their own pace, they would double the knowledge of their own country.

For the first time in two generations the National Government is doing a little something. Members of congress are proposing more aid and state roads.

I introduced a bill for state aid two years ago, and it passed the senate, but was lost in the House of Representatives. I have no doubt whatever that a proper, urgent request, united upon by the people generally, would bring such aid, and that we shall in the end see the best and cheapest system of transportation that the world has ever seen.

It is also undoubtedly a fact that people judge of the progress of nations by their highways, but I am thinking that judgment should be modified a little by the means that are being introduced to take the place of animal power. We judge by the common highways the advance of civilization.

I believe that the time will come when all will see and say that America has led by far all the other countries of the world, both in the cheapness of production and the cheapness of power to move the vehicle.

SYNOPSIS OF UNION COUNTY'S GRAVEL ROADS.

By L. B. Harvey.

We began by building our pikes in 1867, immediately after the law was passed authorizing such improvements.

Our pikes were all, excepting four built under the law assessing the lands within two miles of the road, to be improved, giving the taxpayers five years to pay for the same. The taxes would thus run from 25 cents to $1.00 per acre each year, seldom, if ever, exceeding the latter, which was not considered exceedingly burdensome. Moreover, the taxpayers along the road furnished most of the labor in constructing the same, receiving the pay for the same, and thus partially balancing their taxes.

In the discussion of the causes for hard times in Union County, I have never heard our gravel roads mentioned as one of them, but on the other hand, they have furnished our farmers a way to enable them to market their grain, live stock, and timber, during the leisure time of the year, and at the highest market prices. Also, lands situated upon gravel roads sell for a higher price and far more readily than the same quality of lands on unimproved roads.

Unless the country is very rolling or hilly, or the road subject to quite heavy traffic, or where vehicles are likely to be continually passing, I would recommend a double track, and use a less width of gravel or stone. The side or dirt track makes the best summer road, and saves the wear on the gravel during the dry season, when the grinding is the greatest, besides much easier on horses and vehicles.

The grade for a single track should be 24 feet wide, and for a double track 26 feet, and each should have a crown of at least six inches. Roads can be built on a width of 40 feet, but should be 50 or 60 feet wide, especially where side ditches are required.

We gravel to about the following dimensions: For double track, 11 feet wide, 12 inches deep in center, and 6 inches at sides; for single track, 12 to 15 feet wide, 14 inches in center, and 8 inches at sides. When using crushed stone these depths can be decreased about two inches in center and one inch at sides.

We lay the gravel or stone on top of the grade without any excavation. Excavation might be good in a loose, porous soil, where the waters percolate directly to lower strata, but we have never done so in this county.

A grade elevation of two feet, with water well drained out of side tracks, is, in my judgment, sufficient. We make the ditches at the divides one foot deep, and increase in depth towards the outlets.

We have in Union County over five hundred miles of gravel roads. We collect and use for road repairs two and one-tenth mills on each dollar valuation, or $22,050 per annum, being $44 per year per mile. Our roads are not running down, but on the contrary, are becoming better each year; and it should be remembered that much gravel and material used in construction was not of the best quality.

Our soil is all clay, with few places of gravel subsoil, and is very impervious to water. This makes it more difficult to maintain our roads, the breaks being most frequent where water stands in the side ditches.

The construction of our new roads sell approximately as follows per mile: With gravel to be hauled one mile, $1,000; two miles, $1,150; three miles, $1,300; four miles, $1,450. This includes grading, furnishing material, graveling, and all completed.

DISCUSSION.

Mr. Cronley: "I am well acquainted with the roads in Union County. I want to say that the paper describes the construction of the roads exactly. The roads are all perfectly dry, smooth, and solid. Coming along in the train, I had to observe the splendid roads they had there. I believe it is a matter of history that Union County has the best kept roads in the state."

IMPROVEMENTS OF SHELBY, OHIO.

BY J. B. WEDDELL.

To the Ohio Society of Surveyors and Civil Engineers:

BROTHERS—Shelby, Ohio, is now a town of about six thousand inhabitants, having nearly doubled its population in the last ten years. It is a busy, growing, manufacturing center, having now The Shelby Steel Tube Works,—the largest plant of its kind in the country,—The Sutter Furniture Company, The Ideal Bicycle Works, The Ball Bearing Umbrella Company, and The Easy Spring Hinge Company.

They have a water system, owned and operated by the Shelby Water Company; a sanitary sewer system; a storm-water sewer system; an electric light plant, owned and operated by the town, which, according to their last statement, is so nearly self-sustaining that the street lights cost less than ten ($10) dollars each.

All roads leading into the town are piked with broken limestone, 12 feet wide and 16 inches thick, and the past season two and one-eighth miles of Trinidad Lake asphalt was laid upon the streets.

It is of the sewer system and street paving that this paper is more particularly directed.

The sanitary system is built of vitrified sewer and iron pipe. The mains and outlets have in their construction 12,468 feet of 18-inch vitrified, 1,240 feet of 18-inch iron pipe, 4,168 feet of 12-inch vitrified, and 252 feet of 12-inch iron pipe.

The sub-mains and laterals have 1,320 feet of 12-inch, 3,824 feet of 10-inch, 5,890 feet of 9-inch, and 24,300 feet of 8-inch vitrified; 172 feet of 10-inch and 72 feet of 8-inch iron pipe; 82 manholes, 51 lamp-holes, and 18 flush-tanks; 200 cubic yards of riprap masonry and 480 linear feet of sheet piling, 8 feet deep.

The grades of most lines in the sanitary system are very flat; the mains and outlets are laid on a plain of .91 of a foot per 1,000 feet, and many of the laterals on .2 and .3 per 100 feet; the trenching averaged 10 feet.

The sewage is carried by gravity to the sewer farm, two miles northeast of the town, and there treated by intermittent filtration, and the effluent discharged into the Black Fork of the Mohican. The sewage farm contains twenty-six acres of good farming land, has a comfortable house and barn thereon, and is so rented that its use pays for all the labor and care of the sewage.

The filters will be built this spring after the plan shown upon the attached print.

COST OF THE SANITARY SYSTEM.

While the building of part of the work in the stream, and a number of crossings of the Black Fork, necessitated the use of much iron pipe and break water, and the excessive cost of part of the right of way, all of which added greatly to the expense, yet your attention is called to the very *low cost* of the system, which, it is believed, can be duplicated in other towns no larger than this without overtaxing the people.

The cost is as follows, to-wit:

Sewage farm	$ 2,500 00
Right of way	3,500 00
Mains and outlets	12,320 00
Sub-mains and laterals	17,720 00
Filters, estimated	3,000 00
Engineering	3,000 00
Total	$41,040 00

The upper end of nearly all laterals is furnished with an automatic flush-tank, operated by a Miller siphon, discharging from 300 to 500 gallons each.

The work and materials are first-class, and was let and built under three different contracts. Two of the contractors were honest men, and showed no other disposition than to perform their agreement; the other verified again, that while it is possible to obtain good work from a poor contractor, the effort should be avoided.

STORM SEWERS.

They were constructed by the B. A. P. Co.; contain 7,890 lineal feet, and are built of vitrified pipe of different sizes, from 10 inches to 24 inches in diameter, but principally of 18 and 20-inch; 6 manholes and 54 inlets. They discharge into the Black Fork and its tributaries.

COST.

All pipe 20 inches and over was furnished at 81½ per cent. off standard list price; all pipe under 20 inches was furnished at 84 per cent. off standard list price; labor and cement, 38 cents per foot of sewer, making a total of $5,760.

STREET PAVING.

In the season of 1899, 2.11 miles in length (one and one-half of which lies in a straight line), containing 38,405 square yards of surface, was built by the Barber Asphalt Paving Company, of New York, of Trinidad Lake asphalt.

Proposals, both for brick and asphalt, were received for the work June 3, 1899, to be built upon a five-inch concrete base,

composed of one part natural cement, two parts sand, and enough broken limestone to make a concrete, with all voids filled with mortar.

There was very little difference between the asphalt and the proposals for brick, and the award was made to the B. A. P. Co., they to use artificial stone, curb and gutter, and the whole to be completed in ninety working days.

Following is the substance of the proposal, to-wit:

For all excavation, per cubic yard....................	$ .20
Concrete 5 inches thick, per square yard............	.43
Asphalt, 1-in. binder, 1½-in. surface, per sq. yd.....	1.06
Artificial curb and gutter, per lineal foot	.60
Three-inch sewer pipe (under), per lineal foot......	.03

The curb and gutter was sublet to the Acme Paving Company, of Columbus, Ohio, and built in cross sections, as per print hereto attached.

Labor was scarce; the contract was pushed under disadvantage, but by November 10th the whole work was virtually completed.

The work, both in quality and finish, is the very best of its kind. The contract, in the spirit of the specifications and agreement, was cheerfully performed, and in the final estimate following, you are requested, also, to note the *low cost* of the improvement.

FINAL ESTIMATE.

154,884 cubic yards of excavation, at 20c........	$ 3,097 68
354,826 sq. yds. of asphalt concrete, at $1.49...	52,869 07
219,213 lineal ft. of curb and gutter, at 60c. 219,213 lineal ft. of 3-inch sewer pipe, at 3c.	13,810 42
Sewer inlets..	490 00
Extras	450 00
Total	$70,717 17

Which, per square yard, equals $1.84.

BONDS.

Street improvement bonds were issued, running 15 years, bearing 5 per cent. interest, to the amount of $70,000. They sold at nearly a premium of $7,000. The greater part of this premium was rebated to abutting properties when the assessing ordinance was prepared, which fixed the rate per front foot, on a cash basis, as follows, to-wit:

Roadway 36 feet wide..................	$3 35 per front foot.
Roadway 34 feet wide..................	3 26 per front foot.
Roadway 28 feet wide..................	2 50 per front foot.
Roadway 26 feet wide..................	2 40 per front foot.

The citizens express themselves well pleased with their work, and feel that it is well worth its cost; and that the town stands in the first rank of towns of 10,000 population and less, in the line of first-class improvements.

DISCUSSION.

"What is the average depth of the sewers?"

Mr. Weddell: "About ten feet; some about seventeen feet."

"Where is the sewage farm with reference to the city?"

Mr. Weddell: "About two miles northeast of it."

"How was it paid for?"

Mr. Weddell: "It was paid by general assessment."

"How are the pipes joined?"

Mr. Weddell: "The sewer pipes are joined with Portland cement."

"What per cent. of ground water developed in the sewer?"

Mr. Weddell: "I would say there is probably an inch in depth of ground water temporarily passing in the sewer."

"What is the size of the pipe?"

Mr. Weddell: "The pipe is eighteen inches."

"You consider this a very favorable system of construction?"

Mr. Weddell: "Yes, sir; I think the price is within the reach of any town in the country."

"Why do you use iron pipes?"

Mr. Weddell: "For the strength of the work."

The Old and the New System of Constructing Bridge Masonry, and Their Comparative Cost.

By Charles M. Gordon.

Mr. President and Members of this Society—The subject title of this paper will require a general rehearsal of the past as well as the present mode of building bridge masonry.

The first bridge abutments of any importance built in Brown County are standing today in a good state of preservation. The county commissioners contracted with John Boyle to construct the masonry on the Portsmouth and Cincinnati State Road, crossing White Oak creek about one mile west of Georgetown, Ohio, in 1846. The work and specifications were done under a consulting engineer of this city (Columbus). All face stones were to be not less than four feet long, two feet wide, and nine inches thick, of gray limestone of the best quality. Each face stone was to have at least one bolt hole, one inch in diameter, drilled through each stone, and the bolt to be in length sufficient to bolt six or more face stones together. The cost was $15 per perch.

Brown County, being on the river, requires numerous bridges, crossing the streams emptying into the Ohio river, and foundation for the masonry is of a sandy formation. The engineer not being allowed to use piling for foundations, a great many of the abutments have given away.

It was the aim of the commissioners, for a number of years, to economize in the price of all masonry by having it laid up dry, the rock to be dressed so as to have a smooth bedding surface. Under such misguided economy, bridge masonry has been very expensive to the county.

The high floods of 1883–4 damaged all the abutments and piers along the river, and in a number of instances they had to be rebuilt. The new structures were laid up without cement, and today most all of them show weakness in construction.

In the summer of 1898, we started to rebuild one of the damaged abutments at Ripley, Ohio, crossing Red Oak creek. The base of the abutment was not in proportion to the height, and the consequence was, under a heavy backwater from the river, it went down; cost, $1,456.46 Then one of the commissioners requested me to go on the ground and ascertain the best and most economical way of crossing the creek. I lengthened the bridge span from 56 feet to 100 feet; built a small abutment with cement; bridge and abutment cost $1,337.67, a saving to the county of $118.79.

In my opinion, it pays the county, in every instance, to have the County Engineer go on the ground, and let him have an equal say with the commissioners as to the designing and construction of all bridge work.

After the storm of August 11th, last year, the commissioners allowed me to draw up the specifications to have all bridge masonry laid in Portland cement. By using cement it adds about 60 cents per cubic yard on first cost of work, but it is cheaper in the end for the county.

The North Pole bridge abutment cost $3.85 per cubic yard; Straight creek protection wall cost $3.25 per cubic yard, and we have had some work that cost as low as $2.80 per cubic yard. This is all limestone work, and the material is handy.

The Chasetown bridge abutment, built of freestone and limestone, cost $3.75 per cubic yard. The freestone was shipped on the railroad fifty miles, then on wagons ten miles. I am not in favor of that class of work.

Buckeye bridge abutment at Ripley is built of freestone, shipped by river. Price, $3.50 per cubic yard, laid in cement.

I am of the opinion that all masonry should be laid in Portland cement; and to secure as good a grade of cement as possible, I think the county should buy it for the county work, and then the contractors would not want to use it so sparingly.

DISCUSSION.

Mr. Cronley: "What width would you make the foundation of a bridge 100 feet long? Half the height?"

Mr. Gordon: "My rule is 45 per cent."

Mr. McKay: "I think that the brother is certainly on the side of safety when he uses 45 per cent. I will say, that in our county, our practice has been to use three-tenths and four-tenths, according to circumstances; it depends upon the kind of stone and the specifications. In our own county the cheapest work we have had done has been under specifications where a plan was made for the abutment to ——, and everything made out on that plan, and everything made in accordance The stones ranged from 10 to 21 inches in thickness. We can get that class of masonry in our county for less than any other class that has been designed. The first contract scared the masons and the men that furnished the stone, but when it was once used they would rather get out stone in that way than any other. I would not require as close joints as they do in many instances. Use Portland cement and Portland cement pointing, and you will have as nice a piece of masonry as a man could want. I don't believe an absolute rule can be laid down for the proportion of the base with the height."

Mr. Stump: "I will say a few words in regard to the thickness of the base: it depends very largely on the kind of masonry

you are going to put up. If it is of the kind that Mr. McKay described, three to four-tenths is enough; if it is a different class from that, you want it wider. And about the laying of the stone in cement. Mr. Gordon laid his in Portland cement. We use common Roseville cement, and let it come to within about two or three inches of the dressing line; where it comes closer, we scrape it away, and when we are through, fill up the wall with Portland. It makes it cheaper, and is just as good as if it were all laid in first-class Portland cement."

Mr. Gordon: "When I said 45 per cent., I had reference to our line-stone."

Mr. Stump: "It depends, also, whether you are going to put a bridge on it or not."

Mr. McKay: "One word about Portland-cement: I have given the matter considerable attention, and made many experiments along that line, and I am of the opinion that you can take a good quality of Portland cement and use a sufficient amount of sand to make it cheaper than any possible mortar that can be made; and in addition, if you use a little bit of lime to make the mortar work well, it is not detrimental to the mortar. I have used Portland cement with four and five parts of sand that makes a mortar that is plenty good enough for any ordinary bridge masonry, and, I think, as cheap, and cheaper, than any cheap grades of cement. It is cheaper to use the best cement and use a higher proportion of sand."

Mr. Peters: "My experience has taught me that in using sandstone it is best to make the walls lighter and the joints closer, and use the best cement that can be used, and not make the measurements so heavy. Where limestone is used, make it heavier, with the expectation that it will do the same work. I think economy is in sandstone."

Mr. Weddell: "In reference to dry walls, or walls having mortar, I am in favor of mortar, although some of the oldest masonry in all this country has been laid up dry. Some of the fortifications on the coast of Florida, which were put up dry, are still standing. In putting up masonry as it is usually done in this part of the country, when we use mortar, it is usual to place your stone on the mortar and then dress it off. Whenever you disturb a joint, you have broken the bond, and it is certainly not as good as it was before. I like nice masonry, and as Brother McKay says, you can knock off the points and get a good piece of work by filling it up with good mortar, I think that is true, but it is not as good as if the bond were not broken. I am in favor of close joints."

Mr. Fraker: "I would like to know the experience of the engineers, with reference to concrete abutments, as to cheapness, etc."

Mr. Peters: "I have done some of that kind of work, but I always see it giving away here and there, principally from the

lack of workmanship. If you can have an assistant to stand right by, it can be made first-class. That is the way with everything, but it is impracticable; you are continually getting some bad jobs."

Mr. McKay: "Last season, in the construction of some railroad work, we built four abutments entirely of concrete, and all the foundations of the power-houses and all the engine foundations are made of concrete. Now, that work looks like a good job, but we can't tell. Possibly in a year or two we can tell something about it. I propose to watch it with a good deal of interest, and may have, at a further day, some report to make to the Society. It looks like good work. We have watched it closely, and used the best specifications obtainable for that purpose; it makes a beautiful piece of work, all laid off in blocks of stone."

Mr. Brown: "In regard to the adoption of concrete, it is coming into use very largely. In marshy and hilly country, railroads have adopted it entirely. It seems to me that it is a thing that has come to stay. In regard to inspection, it is necessary that it must be inspected constantly. The engineer should have an inspector on the work every hour the work is going on. Such inspection is necessary. In regard to laying off in blocks, it seems to me it is a useless expense."

Mr. McKay: "One other point that I might add: in our county we have an abundance of limestone, but this concrete work was done at a less cost than we could lay the stone."

Mr. Fraker: "How thick do you make your layers of concrete?"

Mr. McKay: "We specify that they should not be over six to ten inches."

Mr. Weddell: "I would like to ask the Society about the use of cement, that I may be governed by your experience."

Mr Gordon: "We have used the Akron, Louisville, and this year we have used a great deal of the Utica. As to the —— Portland, I think, from experience, that we may judge that as the best Portland we have ever used. The work that has been put in, and subjected to a very heavy test, proves that it was at least very strong after a few days' setting."

Mr. McKay: "It is hard to determine which is the best cement. From some of the tests that I have made, we doubt whether we can tell what the best cement can be; it takes years to find out."

Mr. Cronley: "I want to say a word in condemnation of Louisville cement. We have tried it for a number of years in our county, and once in awhile a car load comes that is all right. When we paved our streets, we used Louisville cement; and about two weeks ago they made an excavation in the street for putting in a water connection, and I picked up two or three large pieces of the concrete. It seemed as hard as adamant, but it was frozen. I laid it to one side in my office, and when people came

in I showed them how hard it was. After awhile it began to thaw out; after it all thawed out, it fell apart, and it was nothing but dust."

Mr. Bowen: "As a rule, we gain knowledge by experience, but my knowledge and experience is like Mr. McKay's. I am satisfied that there are good cements. The Louisville cement—take that as a sample. We may get grades of Louisville cement that are good, but that is no reason, or no assurance, that the next order we get will be equally good. As I understand the condition of things, all the quarries that make this cement are along the river fourteen or fifteen miles, and the quality of stone differs materially in that distance; some is excellent for the purpose intended, and others not so good. I have had occasion to test Louisville cement that has stood the test fairly well, with a reasonable time of setting, and another time it would not stand the pressure; some of it, even as low as twenty pounds, is not much better than lime. Now, the matter of Portland cement, that depends upon the quality of the stone used and the kind of burning. With reasonable manipulation, it would stand a test of 400 to 450 pounds to the square inch, and there was a time that the same factory made a cement that was not fit to use."

CONNEAUTVILLE (PA.) WATER SUPPLY.

By J. B. Strawn, Salem, Ohio.

Conneautville is a small town in northwestern Pennsylvania, situated in a beautiful valley, through which runs Conneaut creek. The town has a population of less than two thousand, although the oldest inhabitants speak of the town in its palmy days, when the canal was in operation, as containing over three thousand souls. "When everybody had employment, and everybody had plenty of money, then we had good times," said one of these ancient worthies. I ventured to ask him if he knew how many pianos there were in the town then? Or whether there were many houses at that time carpeted with body Brussels carpets? Or if they generally had cooking ranges, sewing machines, lace curtains, china and cut-glass, expensive paintings, and well-selected libraries? In fact, had they then the comfortable homes, with all the modern conveniences, that they now enjoy? Had they fine turnouts—matched teams with silver-plated harness, fine carriages, and all the finery that we now see in the town? All this time the old man had remained silent. I cast a look at him; he was weeping. I presume he was thinking of the follies and vanity of human life.

The famous canal became a thing of the past some fifteen years ago. Now the Pittsburgh, Bessemer & Lake Erie Railroad occupies the tow-path of the once bride of Conneautville. In many respects, Conneautville is a delightful little town, especially in the summer season. I know of no place having such fine shade trees, nor so many of them, for a place of its size.

The town is peculiar in another respect: it has no saloons. A law was passed by the legislature of Pennsylvania, many years ago, which placed a perpetual embargo on the saloon business. For some years past, complaints have been made that much of the well-water of the town was unfit for domestic uses; nor was this complaint without good foundation. It was hinted that some of the large-hearted, humane men of the town had provided places where such persons as were afraid to drink water could get a substitute in the form of something warm and inspiring. Hence the absolute necessity of a water supply for the town that should be above suspicion.

In July, 1899, I had a call from a former resident of Conneautville, now the vice-president of the Philadelphia Natural Gas Supply Company, who had been authorized by the council of Conneautville to employ an engineer to design and take charge of the construction of their contemplated water works. As he

was an entire stranger, and I knew nothing about the place or conditions for building of works there, I proposed to visit the place at an early date, and look the place over, as well as the council; that this would probably be the better plan, which was acceded to.

I went, as per agreement, met the council, and had a conference with that honorable body, which had already received information relative to my visit. A proposition for doing the work was asked for by the council. It was made by me, accepted by council, and preliminary work was begun inside of an hour from the time of submitting my proposition.

A good map of the town was furnished me, and such other data as was in the possession of council. Several sources of supply were mentioned, each one having its champion. Conneaut creek was thought, by some, as the only supply that seemed to be ample. This stream, under most circumstances, would be regarded as a very desirable supply. The water-shed is remarkably clean and free from objections ordinarily met with in this country. The stream is furnished by springs, and it maintains its volume more uniformly than will ordinarily be found. To take water from the creek would require a pumping plant, while certain springs were believed to be high enough above the town to enable the town to put in a gravity system; but the quantity of water was believed, by most of the citizens, to be inadequate for a satisfactory supply. Levels were carefully run to determine the elevation of the respective springs, and the routes for conveying the water to the town were carefully noted. The springs were carefully gauged, at different times, to see if there might be any material changes noted. The flow proved to be quite uniform. By accurate measurement, these springs were found to furnish sufficient water to give every man, woman, and child of the town one barrel of water every twenty-four hours. The quality of the water was tested, and found to be as soft as rainwater. The elevation above the town was found to be sufficient to throw a fire stream onto any of the dwelling houses in the general lay-out of the town. There are a few buildings situated on higher ground than the regularly laid out plat of the town. For these buildings the elevation of the supply reservoir at the springs is not sufficient to give efficient fire streams. To overcome this difficulty, a second reservoir was built on high ground in the town, and but 900 feet from the principal street main. This reservoir holds 1,000 barrels, and is 55 feet higher than the reservoir at the springs.

The next problem that presented itself was: How is this reservoir to be filled? For many years the town has had a sort of fire department, but of a somewhat primitive character. The system consisted of a few cisterns, which would hold water when about half full; a fire engine, operated by horse power, and about one thousand feet of good hose. This fire engine was used to fill the fire service reservoir. This feat is accomplished as follows:

On the rising main, from the street main to the fire service reservoir, I placed a valve in the pipe line to the fire service reservoir at a point about one hundred feet from the street main; this distance was given in order to get a suitable location to set the fire engine, which is to serve the purpose of a by-pass around the valve in the pipe line to the reservoir. The fire engine is set opposite the valve just mentioned. The suction of the engine is connected to the branch that is located on the pipe line to reservoir, about ten feet from the valve opposite the engine, and on the lower side. On the upper side of the valve, at the same distance as that of the suction branch, is located another branch on the pipe line to reservoir, to which the hose that is connected to the engine is likewise connected. In this manner the engine takes the water from the lower side of the valve, and passes the water around the valve and into the pipe line, or rising main, to the reservoir. A short piece of hose, with a member of the coupling fitted to the other member, which is leaded into the discharge, completes the arrangement. In this way the reservoir is easily filled; and as this water in the fire service reservoir is to be used only for fire purposes, the filling will occur only after a fire. At the time of a fire, the valve at the by-pass is to be opened, and the valve in the street main is closed, to prevent the water from the fire service reservoir flowing back to the supply reservoir at the springs. More than nine-tenths of the town can be protected from the pressure afforded from the supply reservoir. Hence this filling will be a matter of small expense.

The pipe system consists of about three and one-fourth miles of six and four-inch cast iron pipe, there being 11,600 feet of six-inch and 5,100 feet of four-inch pipe. There are thirty-two double nozzle fire hydrants, with a liberal supply of shut-off valves for dividing the distribution into small sections when required.

In the designing of the pipe system, special care was taken to avoid friction in the pipes, as far as possible. The pipe leading from the springs, which are about one mile from the town, is six-inch cast iron.

The town purchased the springs, with about one and a half acres of land, for the sum of $350; but the owner, who had in operation a hydraulic ram for supplying his premises with water, was not to be interfered with in his enjoyment of his former rights and privileges.

That there might be no loss of water to the town supply, the supply reservoir was located just below the hydraulic ram, with the top of the reservoir level with the base of the ram. The supply reservoir is circular, is thirty feet in diameter, and but four feet deep. It is walled with vitrified shale brick, laid in Portland cement mortar. The reservoir is roofed to prevent the entrance of leaves or anything else getting into it. The springs being in the woods, and some distance from any dwellings, it was thought advisable to have the water supply fully protected.

The water from the springs is conveyed to the supply reservoir by using six-inch socket tile, laid in trenches about two to two and one-half feet deep. The tile are laid loose joint, and gravel is filled around the pipe and over the top to prevent the entrance of dirt or muck; at the same time the gravel will permit the water to freely enter the tile. In all, there are ten branches leading off from the main line of tile. To insure a permanent head of water for the hydraulic ram, the low dam, which had been built when the ram had been placed there, was allowed to remain; and instead of the water above the dam being unprotected as heretofore, a brick well was built above the dam, and the springs which had supplied the ram were collected to the well, from which the ram now takes its supply. The well is also securely covered, making the entire supply secure from any entrance of leaves or other foreign substances.

The effluent pipe, from the supply reservoir, is protected from the entrance of any floating substances or objects that might tend to obstruct the pipes by a galvanized wire screen of quarter-inch mesh. On the supply pipe, at a point 120 feet from the reservoir, I placed a drain-off branch, whereby the reservoir may be drained off without interference to the rest of the pipe system.

This branch was found to be useful in another direction, viz.: for testing the pipe system. The water pipes had all been laid before the work at the springs had been completed. A low dam was built across the stream coming from the springs, and just below the drain-off branch. This dam raised the water, so that the water was turned into the supply pipe, and thus the pipe system was easily filled. Hydrants were opened to let the air out of the water pipes, so that all of the pipe system might be filled with solid water. This done, the little dam was opened and the water was allowed to run as before. As the supply pipe was laid on a descending grade, when the dam was removed, it left the water standing in the drain-off branch, this being the highest point. If any leaks should show up in the pipe system, the water would settle down from the branch through which I had filled the pipe system. The water was allowed to stand thus for three days, during which time there had been no settlement whatever. While this was by no means a severe test, yet it was sufficient to develop any joints that might have escaped the calker and had not been driven, which may happen, or other specially faulty joints.

The pipe system, at the final test, was found to be solid and free from leaks. The fire service reservoir, in material and workmanship, is similar to the reservoir at the springs, but is deeper, being eleven feet deep and twenty-two feet in diameter, holding 1,000 barrels. The reservoir at the springs holds 700 barrels.

This little plant has no very remarkable features about it, excepting the excellence of its water supply, unless I might mention the matter of the location of hydrants in the distribution

The dispatch went on to say that the administration of Honolulu, being on a very model and scientific basis, the probability was that the plague would not spread outside of the Asiatic quarters of the city. This was a striking tribute to modern sanitary science.

We are reminded by these instances of the blessings which public hygienic measures have brought to mankind, and they also admonish us of the importance and necessity of vigilant care in maintaining the same measures.

Notwithstanding the great progress made, municipal sanitation has not received the attention its importance demands. Nearly half a million deaths could be prevented each year in the United States, if preventive measures were as vigorously applied to other zymotic diseases as they are to smallpox. This dread contagion was formerly a chief slayer of human life; it is now the least slayer, having charged to it only four-hundredths of one per cent. of all deaths in the country. This reduction was the greatest sanitary triumph of the nineteenth century. It redounds in particular to the honor of medicine, and to state and municipal government in general. But when we stop to think that it is just as possible, no doubt, to reduce to as great an extent other preventable diseases; and when we stop to think that nearly 500,000 deaths, annually occurring in our country from causes which ought not to exist, are only a fraction of the number of convalescent cases not appearing in statistics, which stand for doctors' bills, and nurses' bills, and apothecaries' bills, and loss of employment, and financial straits, and prolonged handicap in the struggle of life for countless numbers, it becomes apparent that sanitary science has not received the attention that its importance demands, and that there is yet much for it to accomplish.

Who knows how much?

Wonderful progress is being made in every department of knowledge. The splendors of mental achievement are magnificent to behold even at the threshold of the intellectual realm. The magnitude of intellectual forces at work in the practical world, where theories are tried, and proven, and utilized on a stupendous scale beyond the hopes of the most sanguine, is too profound a spectacle for human mind to grasp in its entirety. It is impossible for any one individual to keep pace with the rapid strides of progress. It is only the Infinite mind that can do that. It is therefore presumptuous for man to say what will be the ultimate result on earth of accumulative knowledge and accelerated progress all along the line.

One may reasonably conclude that it is impossible for a train coming down the Hocking Valley Railroad from Toledo at the rate of a mile a minute, and within ten miles of the city of Columbus, to reach the city of Toledo before arriving at Columbus. One may with equal reason conclude that the rush of the times in general, as measured by decades and signified by the ex-

pectancy and events of nations, and the trend of civilization with its gathering impetus, all point to the purpose of a Mighty Will to bring the whole inhabitants of earth onto a plain high and common, and to the enjoyment of blessings and resources which were established for mankind when the everlasting hills were founded.

Some one may ask, When will this time be?

Never, until the sanitary era now dawning shall have brightened into noonday, preventable diseases have been largely driven away, and the vigor of youth extended to its rightful limit.

Disease is the result of disobedience. We shall agree that it ought not to exist, although we may differ in opinion as to whether it did always exist or always will exist. Diseases are of two kinds: local, which may be greatly reduced, and zymotic, which are preventable. Zymotic diseases are caused by infection from without, and are produced by specific germs called bacteria. The functions of bacteria are always in connection with changes in organic matter, either animal or vegetable. Upon the activities of the useful kind even human life depends. The harmful kind prey upon living matter, poison tissue, and produce decay. Bacteria are communicated by water, food, clothing, air, etc. Water is one great medium of communication of specific germs. It is also known that air is a great medium of communicating disease, and that flies and insects may be active agents, and also the dust which floats in city air.

Putrid gases have been supposed to be conveyers of pathogenic germs. The probability of these germs being raised from liquids and transmitted through air is very remote. For instance, the number of micro-organisms in sewer air is very small and less than in the air outside. In sewer air from two to nine germs per liter, and in the air outside an average of fifteen germs per liter, are found; besides, the sewer air organisms are related to those of the atmosphere, and not to the bacteria in sewage. If, by splashing or bursting of bubbles, a sewage germ be raised into the air, it soon falls back by its own weight, so that not much danger exists from putrid gases being specific conveyers of pathogenic germs from liquid surfaces.

But the poisonous effect of the gases themselves is a very different matter. Dr. Allessi's researches in this connection are invaluable. He experimented upon about four hundred animals; two hundred rabbits and guinea-pigs were exposed to putrid gases, and then injected with cultures of the typhoid bacillus, and also the supposed harmless bacillus—coli-communis. Two hundred animals he did not expose to gases, but injected the same amount of pathogenic cultures. From 75 to 100 per cent. of the animals exposed to the gases died, but not one of the animals died that had good air to breathe. Even 83 per cent. of the exposed animals, which were injected with the supposed harmless bacillus, died. These experiments show what a powerful influence putrid

gases can exert upon animals, and admonishes us that breathing bad air predisposes to zymotic diseases; for we may reasonably conclude from the experiments that typhoid fever is not the only zymotic disease which is assisted by the poisonous work of noxious gases.

For these reasons the disposal of all organic wastes should be most carefully attended to. The air we breathe should be kept pure. Not only should putrid gases be prevented, but city dust should be reduced to the minimum. Street cleaning is an absolutely hygienic necessity in cities, and street watering is closely allied to it.

A fruitful source of atmospheric contamination is garbage. In the country, these wastes can be taken care of by the individual householder. In the city, the accumulation is so rapid that the garbage disposal problem is one of the most important. The quantity seems to be the primary cause of its removal, judging from the imperfect methods of collection and supervision which prevail to a great extent. Vessels for its temporary retention often become putrid, swarms of flies and insects infest them, hordes of poisonous bacteria are generated, and the air is inevitably tainted thereby. The future will see destruction of dangerous solids by the application of heat in some form. Incineration is already being practiced with marked success.

We all know that soil pollution by loose cesspools and privy vaults is a nuisance, which has been the most common source of trouble. Experience has demonstrated over and over again that the definite cause of particular diseases has been the cesspool. These methods will continue to be used in the country and in villages, and by proper construction and supervision the health of the members of the household may be reasonably protected. But as the village grows, frequent cleanings become necessary and the disposal of the material is a vexed problem. Finally the nuisance and vexation becomes so great that sewers are built and the nearest stream gets the benefits of the offscourings of the community.

The pollution of surface waters has become alarming. The cities of Ohio turn their sewage into the rivers and streams. Waters which were formerly pure and wholesome and suitable for watering stock and for drinking purposes are now wholly unsuited for these purposes. The use of raw river water for public water supplies has become most hazardous and, in some instances, really criminal. The time has come when the enactment of laws is demanded to protect the purity of all inland waters.

The first century of Ohio's existence as a state is about to close. The event is to be celebrated by an exposition which shall fittingly illustrate the wonderful achievements in every department of progress. The project is to become eminent as an educational institution. Pre-admonished of the marvelous work which sanitation is to accomplish in the new century, and full of desire

to hasten its advancement and success, and believing that no goal is more desirable of attainment than the prevention of disease, the State Centennial Commission contemplate, according to sanitary science, a proper recognition. In one branch of the sanitary department of the exposition, it is proposed to exhibit, on a practical scale, the approved methods of disposing of the liquid and solid wastes of municipalities. The leading sanitarians of the world are to be invited to participate in a course of lectures, and an international congress of sanitation and hygiene is contemplated. The citizens of every municipality of Ohio will have an opportunity to become thoroughly informed on the subject, and it is expected that the practical results of this educational project will save, in dollars and cents, to the various municipalities which must soon undertake sanitary improvements, many times the cost of the sanitary exhibit to the state.

Interest in preventive measures is going on apace, and it does not seem extravagant, in considering the future of public hygiene, to conceive the day when every municipality shall be bound to furnish pure water, pure air, and a well-drained soil, to its inhabitants, and any other than sanitary conditions shall be considered criminal and sufficient cause for legal action, in case of consequent sickness and death.

In forecasting the future of municipal sanitation, which deals with the health of the individual so far as public measures can control, it is difficult to refrain from entering the field of personal hygiene to some extent, since there are diseases which incapacitate their victims and fill hospitals, infirmaries, and penal institutions.

While the sciences of medicine and sanitation have served to save millions of lives, they have also served to keep alive numbers of physically weak and worthless human beings, thereby increasing the great class of hereditary bankrupts and criminals.

It would be better for people physically if they did not have to live in man's artificial city, but there are no indications of a diminution in the growth of urban populations. Centralization seems to be the law. Country life has its attractions, but the city, in spite of its tragedies, and wickedness, and oppression, affords the loveliest virtues, the most generous charities, the glories and splendors and successes of life, and into its maelstrom will teeming multitudes continue to drift. The roar and excitement of business and pleasure in the mighty city, the rush and strife and incessant surgings of the multitude for supremacy and pleasure in all its manifold avenues, make such demands on the human body, that physicians have been forced to observe in consequence, that the American people are traveling down the hill of physical decadence, and that this degeneration will continue in spite of sanitary regulations, if more attention be not directed to the training of the individual.

Be this as it may, one thing is certain, the average length of

life is far below what it should be. 85 per cent. of mankind are said to be unwell, and this seems to be probable. How many among one's own acquaintances are known to be perfectly well after attaining thirty-five years? Life is not what it should be; but a disappointment to the majority, if the testimony of physicians and clergymen, whose ministrations in times of sickness give them access to the heart utterances of the people, is to be accepted. The bloom of youth and the strength of manhood should be extended to the glory of age. Health should not be an ideal state; it should be a normal state, unless we accept the alternative that man, the masterpiece of creation, is a huge failure, a mighty mistake, and this can not be; therefore we are lead, at this auspicious beginning of the century, to stop and ponder our ways, and endeavor to discover if nature has not ordained some way to re-establish man in his lost estate.

We may be assured that nature never begins anything she can not carry out. Sometime her perfect work shall be accomplished. Physicians tell me that the law of heredity, whereby the sins of the fathers are visited upon the children of several generations, has reaped a harvest of physical and mental derelicts, and when man, through want, comes to an understanding of his true condition, the prodigal will return by the same road by which he went forth from his inheritance, that is, by the law of heredity, whereby blessings shall be visited upon thousands who hearken to the voice of wisdom and observe the commandments of nature.

It is recorded in sacred writings that Jehovah made a covenant with mankind. The heel of the woman's seed should bruise the serpent's head, and thereby the hope of mankind should be in posterity. It is to the marriage institution and to the home that belongs the work of physically regenerating a fallen race. Woman may well take up this kind of reform. It is her field by right. This is the avenue through which she may usher in "peace on earth, good will toward men," and I venture the assertion that the twentieth century will witness the organization of women's clubs for this purpose, and even the international federation of such organizations to effect the enactment of laws that shall revolutionize and adjust society.

And when that day shall have dawned in all its fullness, human life will have become improved by many excellencies, offspring will possess redoubled tenacity of life, youth may last to old age as now measured by three score years and ten, and the brightest, most beautiful and perfect specimens of manhood and womanhood of today will then be but mediocrity.

REQUIREMENTS OF THE MAHONING VALLEY.

By Winslow Allderdice, C. E.

Mr. Chairman—This paper is intended to treat more especially the subject of water supply, and the purification of water for municipal and domestic purposes.

While the data herein contained was collected with especial reference to cities in the Mahoning Valley, the application and suggestions may be of interest to other inland localities where the population is rapidly increasing, and the water supply is inadequate at all seasons and of indifferent or positively unwholesome quality. The writer has, for the past six years, given much time to experiments in purifying water by what may be termed a double process, consisting of boiling and filtration. For a long time I was of the opinion that such a process was only feasible at the spigot; in other words, that such a large percentage of the water pumped through city mains is used for other than domestic purposes, that to inaugurate such a process to supply a municipality would be so expensive as to preclude its adoption to any extent. On the other hand, the small apparatus intended for use in each consumer's house is, in its simplest form, expensive for the great mass of the people, and it is among these that disease, as a rule, is most rife. Again, such apparatus requires some care and attention, and it is questionable whether it would be given. Later investigations have, however, modified my views on the point of expense to municipalities, and it is these investigations that I have the honor to submit to the Society.

Boiling or sterilizing Mahoning river water and afterwards passing it through approved filtering substance produces a pure, clear, wholesome water. Samples submitted for analysis to the late Dr. McKeon, chemist of the Union Iron & Steel Co., at Youngstown, were pronounced absolutely pure and wholesome.

The process contemplates the use of regenerative gas furnaces and producers similar to those in use in the National Tube Company's works at Warren, Ohio, Youngstown, and various other places, the principles of which are so well known as to require no drawings or detailed description, unless it may be to state that the furnace or combustion chamber is 24 feet long, 7 feet wide, with arched roof 2 feet high at sides, 3 feet, 6 inches at center, inside measurements. The water will be passed through the furnace in a coil of large thin steel tube, emptying at the upper part of

the combustion chamber into an open pan extending the entire length of the furnace. This permits volatile impurities to escape. From this pan the boiling water flows by gravity through a second coil of pipe placed in a large tank or reservoir and surrounded by water taken from the river or other source of supply. This divides the temperature of the water in the coil. Thus, boiled water 212 degrees F., intake water 60 degrees F., difference 152 degrees. $152 \div 2 = 76 + 60 = 136$ degrees. This tank serves the double purpose of heating the water which is to be pumped through the furnace and boiled and at the same time cooling that already boiled.

I take as an illustration a "Butt weld" furnace running on 2-inch pipe. The average output is 1,200 pipe, 22 feet long, in 10 hours. Weight per foot, 3.66 pounds.

The iron is placed in cold at about 60 degrees F. It is raised to a high welding heat, according to Thurston, 2,400 degrees F. The work of the furnace is, therefore, 2,340 degrees F. With this data we have, 120 bars per hour, equal to 2880 in 24 hours. $2,880 \times 22 \times 3.66 = 231,897.6$ pounds in 24 hours. Reckoning 8 pounds per gallon, equal to 28,987.2 equivalent gallons of water. The iron is raised through 2,340 degrees F. Applying this to the water, $28,987.2 \times 2,340 = 67,830,048$ units. But the water simply has to be raised from 136 degrees to 212 degrees F., or through 76 degrees. Therefore we have $67,830,048 \div 76 = 892,500$ gallons. It has been proven experimentally that the efficiency of gas in a small furnace, acting on water passed through uniformly in a coil and pan, is nearly six times as great as when acting on iron of solid section, where the iron is being constantly handled and the door at one end always open. To be conservative, I take this factor as 3. Applying it, $892.500 \times 3 = 2,677.500$ gallons as the boiling efficiency of one furnace for twenty-four hours. The cost of such a furnace, taken from the books of the National Tube Co., is $4,000. Cost of gas producers, $500. Four furnaces require eight producers. Any good system of filtration may be used, and the water, after such filtration, passed through a coil of tube around which cold water is flowing to further cool it before going into the mains.

The following is an estimate of the cost of a double purifying system for a plant of about 5,000,000 gallons capacity per day:

4 furnaces at $4,000	$16,000 00
8 producers at $500	4,000 00
Cooling coils and connections	5,000 00
Filters and connections	37,500 00
Total	$62,500 00

The filter above cited is based upon the cost of the entire plant at Warren, Ohio, erected by the Cumberland Co., now merged into the New York Filter Co., $15,000, with a capacity of

2,000,000 gallons per day. While I am not an advocate of this system, as it depends upon the injection of a solution of alum to precipitate impurities, the construction and operation afford a reliable basis for estimating cost. The cost of operating such a plant, using two furnaces and six producers, holding the others in reserve, the producers using about five tons of coal each per day ("run of mine" gives the most economical results):

30 tons coal at $1.00	$30 00
2 gas makers at $3.00	6 00
4 laborers at $1.50	6 00
2 filter engineers at $2.50	5 00
Interest, 5% on $62,500	8 56
Incidentals and repairs, estimated	20 00
Total per day	$75 56

Or fourteen cents per 10,000 gallons of water purified. This system would, of course, contemplate the service of water through meters.

It was my original purpose to touch upon the necessity of reservoiring water in the Mahoning river for manufacturing purposes, but this field has been so thoroughly discussed by the State Engineer, Mr. Perkins, in a recent report to the Youngstown city council, that any remarks on this subject, except to concur most heartily in his recommendations, would be superfluous.

TOPOGRAPHICAL MAPS FOR DITCH IMPROVEMENT.

By G. A. McKay.

The application of topography in surveying for ditch improvement, so far as I am aware, has received little or no attention from the engineering fraternity. Perhaps this is partially due to the supposed additional cost of such work, and the lack of time on the part of the engineers to perform the extra work which such a system would involve.

The difficulties encountered in ascertaining the drainage area and benefits to the several land owners where petitions have been presented, either for new improvements or the cleaning out of ditches, as provided by law, led to the adoption of a system and plan of operation of my own for ascertaining the data necessary for the making of topographical maps of the entire drainage area, with sufficient accuracy for all practical purposes, from which the amount of land drained can be ascertained to the nearest acre by merely inspecting and counting the squares on a properly constructed map. By means of the contours, as many classes can be formed as may be desired. It will generally suffice, however, to make three divisions, all between certain contours being classified as lowland, those lying somewhat higher as medium, and a third indicating highlands.

In ascertaining the data for the making of such maps, the section to be surveyed is laid out with lines running at right angles to each other and one thousand feet apart, one set being designated as meridians, the other as parallels. These are numbered, for convenience of keeping field notes, as No. 1, 2, etc. Each meridian line is then stationed off with a chain 200 feet in length, and markers set designating the number of the station on that particular meridian. After the work is outlined in this manner, a party consisting of a level-man and two rod-men, equipped with a right-angled cross, set on a staff, for the purpose of aiding them to fix, by merely pacing the distances on either side of such meridian, additional points two and four hundred feet out, the level-man noting the rod reading and station on such meridian, together with the readings on either side, noting those on the west side as west No. 1 and west No. 2, and those on the east as east No. 1 and east No. 2; continuing in this manner over the entire field to be surveyed, taking such plusses as may be necessary to show any considerable change between stations; also roads, farm lines, buildings, or other objects of importance necessary to

be shown on the map. Such a party in a fairly open country can take the level notes over about 250 acres per day. From such memoranda, the map can be readily outlined to such a scale as may be desirable, and the contours traced on to show any difference of elevation. The cost of surveying and making the maps will vary from seven to twelve cents per acre, depending on the character of the section to be surveyed and mapped.

Apportioning the cost of ditch improvements according to benefits is one of the most perplexing and disagreeable tasks that an engineer has to perform; and he is in need of all the assistance that he can command. By the aid of such maps, assessments may be readily and intelligently made on all the lots and lands benefited by an improvement, and greatly aids the individual assessed in determining the fairness of the assessments and schedule furnished by the engineer.

The advantage of such maps to the individual land owner is considerable. With it, he can at a glance trace out the most feasible line for either an open or tile ditch, and determine the depth and grade that can be obtained. Where land lines or buildings have been carefully located, the original points can be found with a common tape line, with sufficient accuracy to enable him to locate a line where it will drain the largest possible territory. This feature alone would be worth more than it would cost any farmer who owns land that is level enough to require tile drains, as mistakes so common under such circumstances need not occur. The value of such maps for future use, when ditches have to be cleaned out or other improvements made that may become necessary, will be patent to any one who will give the subject any consideration whatever. By the use of percentage, the cost to any individual land owner can be ascertained at once by multiplying the total cost by the percentage for each particular individual.

DISCUSSION.

He stated that in this method the field work is not hard, but that the office work is increased. It requires the location upon the plat of every one of the points you have taken in the field. That requires a paper proctractor, which you lay down on the paper to the zero line, north and south, and then by means of the scale you turn off the angles on the protractor, measuring off the distances and marking off the elevations that you have gotten, and make a point of what it represents. Then complete your contours and exhibit the roads, buildings, etc. It is a great deal of work, but it can be done cheaper in hilly country than the method given by Mr. McKay. I would not undertake to survey 250 acres in a day; I do not think I could do it.

A topographical survey can be made by three men, the surveyor, an assistant and a rod-man, because you only have one line to survey. Of course, it makes it very much easier to have two rod-men and a recorder.

REPORT ON MUNICIPAL ENGINEERING.

By Hosea Paul, Chairman.

To the Ohio Society of Surveyors and Civil Engineers:

Gentlemen — The undersigned, Committee on Municipal Engineering, would respectfully report that the past year has been one of considerable activity, and the reason it has not been much more so is believed to be partly due to the reasons stated in the report submitted by this committee one year ago, which reason then thought likely to operate against improvements was that due to low valuations; that there were many instances where the actual value of property had become greatly enhanced since the appraisal in 1890, and that while the necessity of public improvements had become urgent, it was difficult to charge them up against benefited property, inasmuch as the assessments are generally limited to twenty-five per cent. of such appraisal, regardless of actual value. The adjustment of values this year will tend to remove this difficulty; but where improvements have seemed imperative, the difficulty has been generally solved by the popular makeshift of issuing bonds. To many people it seems easier to pay a debt with a note than to raise the money.

As to assessments, it may be questioned whether the practice, so generally followed, of dividing our cities up into sewer districts does not have many serious objections. In Akron, for instance, there are some nine sewer districts, and T. D. Paul, of the engineering fraternity, is now a councilman and is endeavoring to have all these districts consolidated into a single one embracing the entire city. By thus abolishing the district system, it would give a wider and more equitable basis for taxation of this sort, and render less common those now familiar instances where property has been heavily taxed for main and trunk sewers, without being able for years to come to make any direct use of them, while the only benefit derived is wholly of that general if not remote character that applies to the whole city as well as to a section of it.

Another serious evil of the district system is that the assessment rolls rarely embrace all the property that ought to be taxed. The property of certain kinds of corporations are peculiarly liable to omissions of this sort, a circumstance by no means necessarily due to any undue influence exerted in behalf of such interests, but rather from the practical difficulty involved in listing them.

STREET LINES.

The are many cities in Ohio where the lines of the streets can be exactly determined by durable monuments, and where the

city engineers take pains to perpetuate and extend such lines. There are other cities where very little attention is paid to this sort of work. It would seem that where valuable improvements are put in a street, the lines ought to be carefully defined and permanent bounds set.

SEA LEVELS.

It would seem that the datum or base of levels of any city should be preferably mean sea level, rather than a mere arbitrary quantity, and in case it not being easy to make a change in the city ordinances, some pains ought to be taken to ascertain and record the relation to such sea levels wherever they are within reasonable reach, as they already are in many parts of the state. The necessity of such a system of sea level elevations is becoming especially apparent in these days of suburban electric railways, which occupy so many streets and highways. Such elevations are being rapidly multiplied, and their number and the ease with which they may be found will be a revelation to those who have not recently looked the matter up.

Some classes of municipal improvements, like water works, etc., which involve much use of iron pipe, etc., cost nearly twice as much as they did a year ago, by reason of the decided advance in prices of material.

Much has been predicted of acetylene gas, but so far it has been but little used for public lighting systems, and for this service the electric light is almost everywhere used, and the tendency is everywhere for municipal ownership. A very great economy results from the combination of water supply and electric lighting plants.

LAND SURVEYING.

By J. W. Stump.

Mr. President and Members of the Society—I have attempted to discuss the subject of land surveying, as there are a good many things connected therewith that are of much importance. This subject, though an old one, is like a good many other subjects, that, if they be properly dished up, have a very interesting side. Now, if I don't interest you to a great extent, you may blame me, for it interests me very much the way I look at it, though I may not be able to make it interesting to you. Yet I realize that you, whose gray hairs indicate that your survey will soon surely close, may have discussed the subject in the same light that I shall discuss it, yes, even been practicing it these many years. I have read the reports of "Land Surveying Committees" of the societies of Ohio, Indiana, Illinois, Michigan, Iowa, Connecticut, and even Canada, and have not seen some of these more vital points discussed.

Problems have come before you time after time concerning some very inaccurate work of the early surveyor or the incompetent one. You have passed your opinion as to what would be best to do in such cases, and you have received the opinion of others as to what would be best to do in making a resurvey of the work. Now, this is all very well to know how these questions were disposed of, and what, perhaps, would be the best thing to do with certain cases in the future, but they will be of but very little use to us in our future work, for in making a resurvey, each case is separate and by itself, no general law connecting it with any other. Then, too, surrounded as we are with good instruments and the means of obtaining a good education, accurate work is what we want to do. For then, if the surveyor who follows finds everything all right and just as recorded, our profession is elevated, our work is regarded as being valuable.

Often have I been called out to survey disputed lines, or lands that had lines in dispute. Before going out on these disputed lines, I get a description of all lands lying along this line of conflict. Now, some of you may have had better success in getting descriptions that agree through this disputed line than I have, but I can truly say that it is rare, yes, very rare, that I have found the description of farms to agree on these bounding lines. One of the worst that I have ever had was like the following: A and B each own a farm adjoining each other, and the line of one is supposed to be the line of the other. A's land is described as follows: N. 31° E. 222 poles, 10 links, to a stone on the south bank of Yellow

Bud creek; thence down the same S. 35° E. 2 poles to a stake; thence N. 37½° E. 96⅓ poles to a small barren oak. B's land is described as follows: N. 31° E. 223 poles to a point in Yellow Bud creek; thence N. 40¾° E. 96 poles to a small barren oak. Though the descriptions given above were intended to be the same line, yet you can readily see that there are two lines and that the lands overlap. Now, what I shall deal with is not what I did to adjust matters here, nor to ask you questions as to what you would have done or what was best to do. Questions like these, as to what you did or what was best to do, have been asked and answered for years past. So I deem it of not near so much importance to dispose of a mistake like this when you find one, as to prevent them from ever arising. As a school teacher, I had the best success when I prevented trouble from arising, and not when I let it arise and then tried to dispose of it. So I think of us as surveyors and engineers: not to let such errors creep into our work and then try to dispose of them, but to devise some general method by which such errors can be eradicated forever, some plan by which you can survey a farm and return your field notes to the office, and the surveyor following you can take your notes and resurvey the exact line that you surveyed, and not have to survey two or more lines and then make a great big guess as to what you, perhaps, had done.

In order that we may have correct results or uniformity of results, we must have a standard of instruments, a standard of methods, and a standard of ability, and a law to enforce them. It would be useless to have these standards unless they be enforced, and you can not enforce them without a law.

As to instruments, we should have, first, a good surveyor's transit (most any one of the better makes in the United States is good enough); second, a good standardized steel tape, preferably 100 feet in length; third, a set of steel pins, thirteen inches long and $\frac{3}{16}$ of an inch in diameter; fourth, a set of good, straight flag poles, six to ten feet in length. The county surveyor's transit should be a first class instrument, and the declination of the magnetic needle should be taken at least once each month and recorded. All other transits in the county should be adjusted so that the magnetic needle will have the same reading as the county transit on any particular line. All other parts of the transit should be kept in perfect working order. The county surveyor should have a good steel tape of standard length, and then all other tapes in the county could be compared with this one. In this way, we could secure uniformity of results if we proceeded in the same manner.

As to methods of making a survey, it is not so easy to devise one that can be used again easily at all times in making a resurvey. In the use of the transit, I measure all the angles with the vernier and then calculate the bearings therefrom. In this way I secure excellent results, such as, I believe, can not be obtained

in any other way. In calculating the bearings, I take the needle bearing of that side which seems to have no local attraction. Then, having the angles that the other sides make with this one side, I can calculate their bearings and thus have my problem ready for the application of the table of the natural sines and cosines. In measuring the angles, an error will creep in unless you are very careful. A check can be applied easily to see if there are any errors. If the sum of the exterior angles of the polygon, made by producing each of its sides in succession, is equal to four right angles, then your work with the transit is correct, and all errors that appear in the balancing of latitudes and departures are due to incorrect measuring of distances. If proper care is taken in the measuring of angles, the sum of the exterior angles as obtained by your measurements will be equal to 360 degrees, or lack not more than one or two minutes of it. To illustrate the accuracy of such a method, I will give you a problem that came to me some four week ago. I was called on to survey a farm supposed to have 417¾ acres. I measured the angles with the vernier and checked them and found that they were all right, that is, the sum of the exterior angles was equal to four right angles. Of the sides to measure, all were level ground except one, which was very hilly. Here I set down the transit and helped the boys to do the measuring. The results are given below:

Bearings.	Distance.	N.	S.	E.	W.
S. 35° 5′ E.	5009′	.....	4197	2734	......
N. 57° 1′ E.	3992′	2173	......	3348	.....
N. 26¼° W.	1641′	1472	......	......	726
N. 25° 7′ W.	1932′	1749	.... .	......	820
S 75° 13′ W.	4691′	......	1197	......	4536
		5394	5394	6082	6082

Area equals $417\frac{71}{100}$ acres.

The above example is an illustration of the accuracy we can obtain if we will just take the trouble to do it. In measuring, we always held the tape line horizontal and removed all obstructions so we could measure in a straight line from one corner to another.

The above work shows the very best practical results to be obtained. I do not get such good results every time as the one above, for the next day I surveyed a farm of 200 acres, and the latitudes did not balance by two feet and the departures by one foot. After looking over the work carefully, I found the error due partly to using whole number of feet in the latitudes and partly to error in measuring the angles, for the sum of the exterior angles lacked one minute of 360 degrees.

In our text-books on surveying, there are several rules, by which we are shown how to balance a survey. Now, for my part, I have no use whatever for those rules, for if you find that the latitudes and departures do not balance, you have only to look over your work carefully and you will find just where the mis-

take is. In Johnson's "Theory and Practice of Surveying," pages 205-6, is a problem in land surveying. It is as follows:

Station.	Azimuth.	Distance.	N.	S.	E.	W.
A	164° 3′	838	805	......	......	230
B	205° 39′	1004	905	......	434	......
C	112° 12′	896	338	......	......	830
D	55° 00′	912	......	523	......	747
E	0° .04′	1542	......	1542	......	2
F	269° 32′	1392	11	......	1392	......
A (check) equals 164° 5′			2059	2065	1826	1809

Area equals $56\frac{70}{100}$ acres.

The error in departure as you see is seventeen feet, while the error in latitude is six feet. After showing that there is no error in the azimuth of the lines of any very great importance, Mr. Johnson tells what rule must be used to balance the survey and then applies it to this particular case. This may all be well enough to show how the rule should be applied, but for myself I would be ashamed for anyone to know that I had such an error in my work. Suppose that some surveyor should be called upon to re-survey this farm, some years after, for the purpose of locating some lost corner, and that he does accurate work according to the field notes of the first surveyor. He may miss some of the corners from one to seveenteen feet or perhaps more. This is a sad reflection upon the profession, and it is passed around among the farmers that no two surveyors can agree and thus a law suit is instigated. After the trouble is settled in court the defeated party cannot see why the work of the surveyor who favored him could not stand, and henceforth he has no confidence in surveyors, and the man that did good work has to take the same credit as the man that did bad work. Now after all this has transpired (and it happens at least once in awhile), do you wonder that our profession is not held in high repute? Are we now, as an organization, going to continue to have ourselves classed along with the persons that cannot do good work, or can do good work and are too careless to do it. Are we going to let it be said of us continually that no two of us can run the same line, or no one of us can run a line twice in the same place? Who of the masses of the people, unless he be a good surveyor or engineer, can tell whether you did the bad work or whether I did the bad work? Will we not do something, or have something done, that will lift our profession above the slums and place it among the honored professions of the world? Won't we try to cut out the weeds and thorns that give us so much trouble and that lower the value of a good engineer? When we have done this, it will be said of us as it was of some in olden times: "Suffer them to come unto me for of such is the kingdom of heaven." Many times have I heard it said that a certain person was a surveyor, when in fact he had only an ordinary school education and an old circumferentor with a "Jacob Staff."

In addition to this he very likely had a two or a four rod link chain that had been in use these many years. With such an outfit what kind of work could you expect? Now, the ordinary man thinks that he, since he possesses these instruments, is just as good a surveyor as anybody. I, for one, am not willing to continue fighting my way with such a class of supposed surveyors if I can help it. Such a class of professionals are no good to the people they work for, nor to the profession they represent. The trouble and expense that will come in after years from such work, will cost many time the expense of a good surveyor, say nothing about the bad effects upon the profession. If we are worth anything at all we are worth being protected as others are. And by protecting ourselves we protect the people we work for, and thus hold our profession up in rank and dignity with other professions. In this age of the world and protection we should have our share. There is scarcely an organization on the face of the earth that does not seek protection in some way, and why shouldn't we? Such bad work as is mentioned above is not common only with farm surveying, but it is almost as bad in city surveying. Time after time have questions come before this society as to what would be best to do in certain cases in city work, because of the surveyor doing bad work in the field, or failing to record on paper just what he did or just what he intended to do in the field. In balancing up a survey the sides are given weights according to the difficulty in measuring them. In the first problem given above one side was much more difficult than the others, yet by proper care the length of that side was obtained just as well as the others. Now, my method is this, that if there are sides that are more difficult to measure than others, we should take just as much more care in measuring them. In all cases we should take such care that we know that our work is sufficiently accurate.

Section 1168 of the Ohio Statutes says that in the calculation of the area of land, that it shall be done by latitudes and departures. This is all right in my estimation as far as it goes, but why be so particular about having a good method of calculation when the methods of obtaining the field notes are very irregular and faulty? Can you have a good substantial building by placing a fine structure on a weak foundation? Can you purify tainted meat by boiling it in an aluminum pot? Then, as stated before, in order to have good results and uniformity of results we must have, first, a standard of good instruments; second, a standard of methods of using them; third, a standard of ability to use them; fourth, like every thing else, we must have a law enforcing each of the above requirements. When this is done, then will our profession take its rank above the ordinary level and the people will realize that there is something else required besides an old link chain and a circumferentor.

Some states have no county surveyor's office, and some that have talk of abolishing the office, for they regard it as being a

needless expense. Brethren, will we not have our profession recognized by the laws of our country, as it should be? Do we deem ourselves so unworthy that our statutes should take no notice of us in any respect? Are we going to sit here idle, claiming the name and bearing the name of engineer, while others who lay no claim to the title whatever beat us ten to one? The county surveyor's office is the only place that our State Government can recognize our services to any great extent, and we should demand that we be properly recognized here. Then there should be general laws passed bearing on the requirements of surveyors and engineers. Mr. C. G. H. Goss in his address before the Indiana Engineering Society, makes use of some sentences that should receive the attention of surveyors and engineers. Some of them are as follows: "It has been charged and admitted that the civil engineer is not, as a rule, a business man. That the average engineering graduate is not able to use the English language as readily as a professional man should. That perhaps nearly five per cent. of these engineering graduates were unable to write the English language correctly."

Quite a discussion followed the reading of Mr. Goss' paper as to why the surveyor and civil engineer did not receive the respect that he should. Some maintained that his college training was incomplete; that he lacked confidence in, and respect for himself; that he had no business qualifications; that the majority of the people did not think it possible to get an honest man; that it was due to some working too cheap, etc. No doubt that nearly all that took part in the discussion were in the right, yet some may have been in the wrong. It has been held that a student could not get a business training in our engineering schools. Now, I think that it is possible for a student to get both a business training and a practical education in our engineering schools. This can be done by giving the students more education and less learning, something business-like and practical instead of the bosh that is in every engineering course, and which is of no more use to the practical and business engineer than the paper on which it is written. Let the professor take his students out into the field and stay there two or three weeks at a time, if necessary. Let him take them through the entire routine of constructing a county ditch, or a turnpike, surveying farms, running disputed lines, constructing bridges and masonry, etc. For, three weeks of training of this kind is worth more than a whole year at any engineering school, for the purpose of a practical and business education.

I took a course at the Ohio State University, and will have to say that the course there is as good as any engineering course in the United States. But the course there is like the course at other colleges, it draws too much from the technicalities and not enough from the business and practical methods. If the professors of civil engineering would adopt into their courses some-

thing like I spoke of a moment ago of taking the students out into the field for two or three weeks and giving them a practical training, it would not take fifteen or twenty years after the graduate leaves school for him to become a good practical engineer, as it has been claimed. Then if it be required by law that the engineer possess a certain standard of ability in the profession, we as professional men would not be underated by the cheap man. It would be heard around that "the engineer said so and I know it is a fact." Would we be held in low repute then? You have heard that little drops of water and little grains of sand make a mighty ocean and a beauty land. So I think with our profession. In order to make it mighty and beautiful we should have the very best practical and business course possible in our schools; we should have our profession represented in every business of importance, e. g.: in the State Legislature, State Board of Health, etc. We cannot sit down in this day and age of the world and wait for men to come to us. We must go to them and go with something attractive, something beautiful, something desirable, something valuable.

DISCUSSION.

Mr. Harper: "The only thing that I regret is that the speaker had to take occasion to attack the Ohio State University. I think the best one to reply to that is Prof. Brown."

Prof. Brown told the Society what work was done at the Ohio State University in the engineering course.

Mr. Kline: "I feel satisfied that everything is done at the State University to make the course what it should be, and if we engineers could go through the course again, we should find enough to amuse us while there. The course is as complete as it can be. If every surveyor, before taking such a course, could be a college graduate and then take up the engineer's course, it would be a good thing; but every man is not able to do this. Some possess natural ability and they become as competent and work out as high a degree of success as those who have gone to a state university.

Mr. Fraker: "It has always appeared to me that the rough edges appearing upon men, or students, who have little experience, is due to their inexperience with the nature of men, for inexperienced men are unable to cope with experienced contractors, and whenever a student is able to read human nature so that he can stand and look at the contractor and tell what he is thinking of, then he is capable of doing business. But a great many of those things only require patient observation to put a man in a condition that he is capable of doing the work. Students usually teach a few years following their course. They associate with boys and girls, and instead of developing the power to read human nature they lessen it, and they have certainly got to get that before they can do the work that is required of them."

Prof. Brown: "It isn't our expectation to attempt to turn young men ready to take positions of city engineers, or chief engineers of railroads. I have never recommended a young man for such a position. I always try to impress the young men with the fact that they must serve an apprenticeship. Engineers expect too much of boys, expect that they must know everything. They don't. It isn't possible for them to. I have heard engineers speak impatiently of college graduates, because they couldn't do this and that. Of course they couldn't. You can't learn to get along with contractors in college. It is always my recommendation that the young man take a subordinate position first and get that actual practical education.

"In regard to taking a college course first, I always recommend that, I think it preferable. If a man could take a four years' college course and then about two to three years more in a professional course, he would be much benefited.

"Another thing, after he has been in school two or three years drop out for a year and secure practical work and then come back and finish his course, that is a great benefit."

Mr. Jones: "I hardly think that last suggestion would do. I dropped out and went to work and never returned. One thing might be added to the course, that is mind reading. In praise of the Ohio State University, although they are not yet nearly as well equipped as many of the universities for that course, the Ohio State University turns out as many graduates as any technical school in the United States, who afterwards make a success and are able to take care of themselves. I have followed up the course of many of the older students and they are nearly every one still in the business and have made a success. I noticed some time ago a list in the 'Engineering News,' giving the per cent. of graduates in the civil engineer's course that were engaged in the business at the present time, and the Ohio State University was the largest of any given in that list."

Mr. Weddell: "If I could live my life over again I could better it. I am very much in favor of taking a complete course in college, and then that would give me a foundation. I would then take up the profession that I wanted to follow. The training I would receive by taking the course would help me to sit down and think, and think. It would be the proper thing for the student to take a complete course in college, they will always feel the benefit of it, and it will make them more proficient.

"Now, as to practice, I believe it is true in one thing as well as another. I have known of people learning to be musicians to practice day after day and year after year for the training that they might afterward put in practice. They have the ability to sit down by the hour and hour and think continuously. If I have anything to say to someone about to commence a course it is, to do well what they are after, no matter if it takes two or three years longer to get an education."

It was moved and seconded that the Society adjourn until Friday morning. Motion carried.

Mr. Riggs, of the Michigan Society, was called on to address the Ohio Society. He said: "While I am not a member I am interested in the Michigan Society. I am an old resident of Ohio. I have been very much interested in the road discussions this afternoon, but I do not know if I have anything to add to what has been said. There are a few points, however, which may be of interest to the members of the Ohio Society, possibly of some benefit to the Society in the matter of operating and running the Society, and these points are suggested to me by your Secretary asking three or four questions.

"I would like to tell you about our experience in raising money. We were in the hole three years ago and now we are out, with an active membership of about the same as yours, and a total membership of perhaps one hundred and fifty. Three years ago we found the same difficulty that your Secretary reports in the matter of raising money to pay for the publication of the reports. It is a very difficult matter for one man to secure the necessary advertising. It requires a large amount of work and it was the practice of our Society to put all that work on the Secretary. Three years ago we appointed a committee of five. We picked out men that would work, and every year we reorganize the committee, if it needs it. The men that work we have work. We divided the state into districts and systematically canvassed the state for advertising. In Chicago, Toledo, and some other cities we put it into the hands of agencies. We never lost a dollar by that method, and that supplemented by the work of the committee enabled us to pay for the publication and a large part of other expenses. It will give us an opportunity to have a personal and an editorial department. We need to do better work and more practicable work. The annual report can be in the nature of a quarterly. It is hard to get advertisers for an annual report, and it is merely a matter of courtesy that they advertise at all.

"The Michigan and Ohio Societies do the same class of work and reach the same class of people, but the societies are not attended as they should be. There are a great many in this city who are practicing the profession, the majority of whom take no interest whatever in any society work. There is nothing that so broadens and develops and enriches the engineer as to meet with other engineers for discussion, and have some of his false ideas corrected.

"I wish the Ohio Society all success."

LETTER

FROM PROF. A. A. WRIGHT, OF OBERLIN COLLEGE.

To the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—At your annual meeting two years ago, you did me the honor of inviting me to address your body in explanation of the pending bill for the inauguration of a topographic survey of Ohio in co-operation with the United States Geological Survey. At the close of my address, some questions were propounded about the practical management of the proposed survey, which I was unable to answer at that time for lack of sufficient information. One of these, which I recall, was, whether there would be any opportunity for Ohio surveyors to participate in the field work of that survey, or whether all the work would be done by men who are permanently attached to the Survey at Washington.

During the later progress of the canvass, Mr. Herbert M. Wilson, Geographer of the National Survey, came to Columbus twice, at our solicitation, to explain more fully the nature of the Survey to the legislative committees, and to guarantee the good faith of the United States Survey in the matter of co-operation.

Mr. Wilson stated that it was the policy of his bureau to employ local engineers and surveyors, in accordance with the regulations of the Department of the Interior, for as large a part of the work as possible; only the trained and experienced chiefs of parties being sent out from Washington.

He also gave the information that the money furnished by the state is used for the purchase of subsistence, transportation and supplies for the surveying parties in the districts where the work is progressing. All of this money is, therefore, kept within the state. On the other hand, all the money for salaries and wages of surveyors and their helpers is furnished from Washington, so that a considerable portion of this fund also will be retained within the state.

It is thought that these statements would be of interest to the members of your Society.

It is regretted that notwithstanding the best efforts that could be made, and notwithstanding the strong support given by your Society, the bill failed to pass. We are compelled to try again, and the valuable influence of all your members is earnestly solicited. Since the time when Ohio hesitated, Pennsylvania and Maine have undertaken surveys upon this plan, and every such arrangement with a new state tends to prevent the rapid progress with the work in Ohio that might be made without it. It is doubtful if there will ever be a more favorable time for inaugurating the survey than the present year.

I have the honor to be, Very respectfully yours,

ALBERT A. WRIGHT,
Chairman Committee of Ohio State Academy of Sciences on a Topographic Survey.

DISCUSSION.

Mr. Weddell: "I think that a scale of an inch to a mile is a very small scale. I see there is nothing said about giving us in this state a system of precise levels."

Mr. Brown: "That goes with it; that is stated; that is the basis of all contour work."

Mr. McKay: "One other objection: it don't provide that any portion of that committee shall be engineers."

Mr. Brown: "It isn't at all necessary."

Mr. McKay: "Don't you believe that such a committee ought to be partially engineers?"

Mr. Brown: "It might be well. The method is thoroughly mapped out by the Geographical Surveying Department. In regard to the scale of one mile to an inch, fine contours depend upon how far you put your contours apart. If it is level, you can put 500 contours, and in a hilly country only about fifty."

Mr. Weddell: "These levels you speak of as the basis of contour work are simply approximate."

Mr. Brown: "In regard to that, a number of years ago the United States Map and Geodetic Surveying Department undertook the survey of a line by a chain of triangles across the continent along or near the thirty-ninth parallel, partly for scientific purposes and for other reasons. That survey included the triangles and the line of precise levels that has been furnished. This chain runs through Ohio and extends along the B. & O. west and east and goes on through. They left a bench mark along that B. & O. on every bridge. In every county seat, they left a bench mark on some public building."

"What was the cost of that survey?" Answer: "It was estimated at $5.00 per mile."

Mr. Weddell: "Shouldn't the time for the completion of this work be four years instead of eight, as it now is?"

Mr. Brown: "You might make the appropriation $50,000 instead of $25,000 and do it in four years, if you prefer to do it that way."

Mr. Gordon: "It might be advisable for the association to leave it just as it is. If the bill goes to the Senate and is defeated, it will be defeated on account of money. It was defeated before on account of the appropriation."

Mr. Paul: "My knowledge of the affair is, it was defeated on account of the $25,000 to raise. If we couldn't get it through at all for that amount, I am sure it would be impossible to get $50,000. I would think a simple endorsement of that bill is all that is necessary. Let the members of the Legislature understand that the bill has our endorsement. If we don't, it may be inferred that we are opposed to it. If there is to be an amendment, let it be brought in the lobby."

CEMENT WALKS, CURBS AND GUTTERS.

By H. L. Weber.

Cement walks, curbs and gutters are to a city what carpets are to a house; "ornamental as well as useful." From a sanitary point of view, they are *par excellence*. The essential thing to secure the best results, is to first establish a system of grades. All cities, no doubt, do this, but small towns, where an engineer is not regularly employed, as a general thing are sadly lacking in this regard. I never undertake a piece of work unless the town authorities consent to have this done first. If they do not see it that way, the other fellow can have the job, and the grief that is bound to come afterward. Some time ago, I was called upon by the town board of Cambridge City, Ind., to recommend the kind of walks best suited to the requirements of that town. After carefully looking over the situation, I recommended the use of cement as the material best suited to their needs, and which would be the most reasonable in cost, considering everything. For main business streets, walks fourteen feet wide; for residence portion six feet wide. The fourteen foot walks to have a curb constructed on the edge, as shown by the plans and fully described in the specifications, which are embodied herewith, and which, I think, will explain matters better than anything else I could offer on the subject.

This work was let at the following prices:

6-foot walks	$0 56	per linear foot.
10-foot walks	94	per linear foot.
12-foot walks	1 12	per linear foot.
14-foot walks	1 32	per linear foot.

The excavation averaged twelve inches deep. All the gravel and sand were within one-half mile of the work, and cost five cents per load and the hauling. Drain tile twenty-five cents per rod, delivered upon the work. The contractor claims to have lost money on the work, and I am sure this is the case. My estimate on the work was eleven cents per square foot. Portland cement was adopted and used throughout the work.

SPECIFICATIONS FOR CEMENT.

Section 1. The contractor shall do all the labor and furnish all materials necessary for the completion of the cement walks and accessories as herein specified, and also furnish all labor and materials required for protecting and repairing adjacent structures, maintaining public travel on the street or intercepted roads,

walks and streets; and all labor and material required for any of the operations, principal or collateral, mentioned or implied herein.

All materials and labor shall be subject to the inspection and acceptance by the engineer and superintendent in charge.

SUB-GRADE.

SEC. 2. Excavation shall be six feet wide and twelve inches below the top of the grade stakes, and as shown by plans. The material excavated shall belong to the city, and shall be delivered by the contractor to such lots or tracts of land abutting upon the improvement, and after such lots have been properly filled, the remaining material shall be delivered to such points as the Board of Public Improvements or engineer may designate, provided the haul does not exceed one thousand yards, otherwise said material shall belong to the contractor.

SUB-DRAINS.

SEC. 3. Sub-drains shall be laid of four-inch common drain tile, six inches below the sub-grade as shown by the plans The tile shall be laid to a true grade and line, with close fitting joints, and with clean gravel packed around and over them to the top of the trench. The tile shall be connected to such outlets as the engineer may determine. All junctions to be made with "Y" and "T" branches, and all deflections with curves of vitrified sewer pipe.

FOUNDATION.

SEC. 4. Upon the sub-grade shall be placed clean, coarse gravel, six inches in thickness after being thoroughly wet and rammed, and to a uniform depth of six inches below the finished grade.

CONCRETE.

SEC. 5. Upon the foundation shall be placed the concrete, to fill the templets within one inch of full, which shall be five inches thick after being thoroughly rammed to place. The facing shall be placed in the templets forming the curb; backed up with concrete thoroughly rammed to place.

The concrete shall be composed of one part cement, two parts sand, and four parts gravel. The gravel can contain the sand. After mixing the cement, sand and gravel thoroughly together in a dry state, add sufficient water from sprinklers to make a medium dry mixture; place and thoroughly ram until free mortar appears upon the surface.

The proportioning of the cement, sand and gravel shall be done by placing a templet of the proper size upon a platform, and placing therein the cement, sand, and gravel in the proper quantities, and leveling off each with a straight edge. Remove

the templet, add clean water and thoroughly mix to make a concrete of such consistency that when deposited and rammed to place, shall envelope every particle of sand with cement, and every particle of gravel with mortar. This result must be obtained to the entire satisfaction of the engineer.

The concrete shall be laid in blocks of the following dimensions: Six by seven feet for a fourteen-foot walk; six by six feet for a twelve-foot walk; and five by six feet for a ten-foot walk, with the joints separated by tarred paper.

WEARING SURFACE.

SEC. 6. Before the concrete has set, deposit the wearing surface, which shall be one inch in thickness, composed of one part cement and two parts clean, coarse, washed sand; first mixed thoroughly in a dry state, then passed through a No. 3 sieve; then moistened with sufficient clean water, and thoroughly mixed into a medium stiff mortar. Deposit this upon the concrete, and trowel down to insure a perfect contact. Then level with a straight edge from the grade strips. When sufficiently hard, float and trowel to a smooth continuous surface. Avoid dusting the surface with dry cement.

The surface, except a marginal draft one and one-half inches wide around each plate, shall be pitted with a brass roller acceptable to the engineer. The wearing surface shall be cut into blocks the same size as the concrete base. As soon as the work has properly set, all templets to be removed and edges plastered to the full depth of templets. All walks shall have a rise of one-fourth inch per foot from the curb to the lot line. Stake strips shall be set on both sides of the walk to keep it straight, being careful that the level and fall are right.

CEMENT.

SEC. 7. The cement shall be the best American Portland, or any other equally as good or better. No mixing of different cements will be allowed. Any of the Portland cements will be acceptable.

All cements must meet the following requirements:

Fineness.—Not less than 95 per cent. to pass a fifty mesh sieve, and not less than 85 per cent. to pass a hundred mesh sieve.

Time of Setting.—Initial set in not less than one hour.

Tensile Strength.—One day, neat, 125 pounds. Seven days, neat, 400 pounds.

Constancy of Volume.—Cement shall not contain more than 3 per cent. of magnesia, and must remain perfectly flat and free from cracks after remaining in water for twenty-eight days, and shall stand, without cracking, a temperature of 212 degrees Fahrenheit, after immersing in water for twenty-four hours.

All cement shall be kept in suitable houses for the purpose.

SAND.

SEC. 8. The sand shall be clean, washed, coarse river or bank sand, acceptable to the engineer.

WATER.

SEC. 9. None but clean, clear water shall be used, which must be furnished by the contractor.

As soon as a section is finished, it shall be protected by placing muslin, canvas, or sand thereon, and in dry weather it must be kept moist for five days by thorough sprinkling.

STREET CROSSINGS.

SEC. 10. Where driveways, alley crossings, or street crossings occur in the line of walk, the walks will be made of special construction as shown by plans.

TREES, ROOTS, ETC.

SEC. 11. Trees shall not be injured, but roots of trees, which in any way interfere with the construction of the walk and its maintenance in proper manner, shall be cut away as the engineer may direct. The pavement shall be properly fitted around all fixtures in the walk.

RELAYING, ETC.

SEC. 12. Where the material in any walks that now exist on the street shall be acceptable to the Board of Public Improvements, they shall be relaid to the grade and line established; the price therefor shall be determined by adding 10 per cent. to the actual cost of the work as determined by the engineer.

WORK SUSPENDED.

SEC. 13. Any work not finished in the time specified, shall be discontinued for the season, upon notice from the Board of Public Improvements, and not again commenced until said Board shall order the contractor to begin work. No work shall be laid in freezing weather.

STEPS.

SEC. 14. At points where it will be necessary to construct platforms, steps, or other appurtenances, along any building in order to harmonize said building to the established grade, the outside line of said appurtenance shall be .... feet from the curb line, and parallel therewith, and constructed as shown by plans and detail drawing.

CEMENT CURB AND GUTTER.

SEC. 5*a*. The cement curbing and gutter shall be constructed in place under the directions of the engineer, upon a bed of gravel ten inches in depth, afterward flooded with water and compactly

rammed to an even surface, under which a four inch drain tile has been laid, as shown by plan. It shall be composed of concrete, formed by intimately mixing dry one (1) part of the best Portland, adopted for North Sixth Street and Ft. Wayne Avenue. Portland cement, two (2) parts coarse, wash sand, and a sufficient quantity water added afterwards to form as stiff a paste as it is practicable to work, to which add four parts of clean crushed limestone, crushed to pass through a one (1) inch screen. The stone shall be sprinkled before it is added to the mortar. The proportions given being intended to form a concrete in which every particle of sand shall be enveloped by cement, and every particle of stone enveloped by mortar, and this result must be obtained to the satisfaction of the engineer. It will then be placed in the templet and thoroughly compacted by ramming until free mortar appears on the surface. All exposed surfaces shall be covered with a finished coat one inch in thickness, composed of one part cement and one part of fine screenings, and all edges plastered to the full depths of templets. The facing shall be placed in the templets forming the curb; backed up with concrete, thoroughly rammed to place. The top facing of curb and gutter shall be thoroughly troweled to insure perfect contact. When it has become sufficiently hard, float and trowel to a smooth, continuous surface. The curb to be constructed with the top edge to the established grade of the street; the upper and lower face corner to be rounded to a radius of one inch. The curb shall be six inches thick at the top, and the gutter eight inches thick and twenty-eight inches wide, and constructed in seven-foot sections, alternately. When the intervening sections are constructed there shall be a strip of tarred paper placed in the joints.

CEMENT CURB AND GUTTER.

SEC. *5b.* Upon the foundation shall be placed the concrete, to fill the templets within one inch of full after being thoroughly rammed to place. The facing shall be placed in the templets forming the curb; backed up with concrete thoroughly rammed to place. The top face of the curb and gutter shall be thoroughly troweled to insure perfect contact. When sufficiently hard, float and trowel to a smooth, continuous surface.

The concrete shall be composed of one part cement, two parts sand, and four parts gravel. The gravel can contain the sand. After mixing the cement, sand and gravel thoroughly together in a dry state, add sufficient water from sprinklers to make a medium dry mixture; place and thoroughly ram until free mortar appears upon the surface.

The proportioning of the cement, sand and gravel shall be done by placing a templet of proper size upon a platform, and placing therein the cement, sand and gravel in the proper quantities, and leveling off with a straight edge. Remove the templet,

add clean water and thoroughly mix to make a concrete of such consistency that when deposited and rammed to place, will envelop every particle of sand with cement, and every particle of gravel with mortar. This result must be obtained to the entire satisfaction of the engineer.

The curb shall be constructed with the top edge to the established grade. The upper and lower face corners to be rounded to a radius of one inch. The curb shall be six inches thick at the top, and the gutter eight inches thick and twenty-eight inches wide, constructed alternately in seven foot sections. When the intervening sections are constructed, there shall be a strip of tarred paper placed in the joints if deemed necessary by the engineer.

In 1899 we constructed 2,770 feet of combination curb and gutter in Richmond under Section 5b. The alley crossings and crosswalk were also constructed under the same section. It is giving splendid satisfaction and presents a very fine appearance. The roadway is macadam. The curb was first constructed, the macadam then filled in to an inch and a half above the curb, and rolled to place with a four ton horse roller until it presented a solid, smooth surface, flush with the curb or slightly above it.

We have also constructed various things under the same section of the specifications. One thing worthy of note is a fountain bowl in one of our parks, which is shown by an accompanying photograph. This bowl is eighteen feet in diameter and is a very nice piece of work.

The cost of the combined curb and gutter above mentioned was about eighty-five cents per linear foot, and the cost of alleyways and crosswalks fourteen cents per square foot.

RESOLUTIONS ENDORSING TOPOGRAPHICAL SURVEY OF OHIO.

Resolved, By the Ohio Society of Surveyors and Civil Engineers, that we endorse most heartily the proposal for co-operation on the part of Ohio with the United States Geological Survey for the production of a topographical atlas of this state, as provided in House Bill No. 87.

We believe that it will benefit every locality in the state and will minister to business interests as well as to the cause of education and science.

We believe that Ohio ought not to be behind the other states that have secured their topographical maps in this way.

We pray our Legislature to enter upon this work at once and complete it as rapidly as may be practicable.

Adopted unanimously.

A BILL

TO AUTHORIZE A TOPOGRAPHIC SURVEY OF THE STATE IN CO-OPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY.

Be it Enacted by the General Assembly of the State of Ohio:

SECTION 1. That the Governor be and is hereby authorized to appoint a commission, to consist of four citizens of this state, from the two leading political parties, not more than two of whom shall be of the same political party, qualified by education and experience for such service, to confer with the director or the representative of the United States Geological Survey and to accept its co-operation with this state in the preparation and completion of a contour topographic survey and map of this state, which is hereby authorized to be made. Said commission shall serve without pay, but all its necessary expenses shall be approved by the Governor and paid out of the State Treasury. Said commission shall have power to arrange with the director or representative of the United States Geological Survey concerning this survey and map, its scale, method of execution, form, and all details of the work, in behalf of this state, and may accept or reject the work executed by the United States Geological Survey. And it is hereby provided that said map shall accurately show the outlines of all townships, counties and extensive wooded areas in this state as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads,

streams, canals, lakes and rivers; and shall show by contour lines the elevation and depression of the surface of the country.

SEC. 2. For the prosecution of this survey, the sum of twenty-five thousand dollars ($25,000), is hereby appropriated for the year 1900, and an equal sum for the year 1901, and the auditor is hereby authorized to draw his orders on the State Treasury for such portions of these amounts as may be required from time to time, from any money in the State Treasury to the credit of the general revenue fund, and not otherwise appropriated, upon vouchers signed by the three members of the commission; but it is hereby provided that these expenditures shall not be in access of the amounts expended upon the same work by the United States Geological Survey from its own funds at the rate of five dollars per square mile of territory surveyed.

For the purpose of making the surveys hereinbefore provided for, it shall be lawful for the persons employed in making the same to enter upon all lands within the boundaries of this state, but this act shall not be construed as authorizing any unnecessary interference with private rights.

This commission shall on the 15th day of November of each year make a full and itemized report of the work accomplished and money expended up to that date, and file such report with the Governor not later than the 15th day of December following.

SEC. 3. This act shall be in effect immediately upon its passage.

OBITUARY.

Dr. Edward Orton, late Professor of Geology at the Ohio State University, one of the most learned and distinguished educators of the country, died since our last annual meeting.

Dr. Orton came to Columbus in 1872, to accept the Presidency of the University here, with which he has ever since been connected. He was a man of rare intelligence and great executive ability, and did more than any other man to place the University on a substantial footing. After serving as President of the University for ten years, he became restless under the miscellaneous duties devolving upon him and he resigned, that he might devote his whole time to his chosen study; that of geology. He remained in the University as Professor of Geology during the remainder of his life. His earnest zeal and devotion to the study of nature was remarkable, and he was ever seeking for light in dark places, and for truth where doubt prevailed. His way of presenting subjects and imparting knowledge was most interesting and logical. He saw the bright side of nature, the best traits of man, and certainly believed that life was worth living.

Early in the history of our Society Dr Orton gave us recognition and substantial encouragement by his presence and activity as a member. He was made an honorary member of our Society in all that the term implies. He met with us at our annual meetings and gave lectures and discussions that were always interesting and instructive.

But alas! He is dead. One chair at our meeting in January, 1900, was vacant which never can be filled. Such is life. Peace be to his ashes. Farewell.

B. F. Bowen,
J. W. Stump,
A. W. Jones,
Committee.

Resolutions on the Death of Samuel J. Baker.

We, your committee appointed to draft resolutions on the death of Samuel J. Baker, of Cleveland, Ohio, beg leave to submit the following report:

Whereas, It has pleased the great Engineer of the universe to remove from our midst our fellow member whose death we sincerely deplore; therefore,

Resolved, That this Society extend to the bereaved family and friends its most profound sympathy for the loss of a worthy and true friend and esteemed citizen; and

Resolved, That in his death this Society has lost a faithful and valuable member whose presence will be sadly missed at our meetings.

J. M. HARPER,
J. B. WEDDELL,
Committee.

MR. SAMUEL J. BAKER

Was born in Dorchester, Mass., April 10, 1854, and moved to Cleveland with his parents at the age of three years. He was educated in the Cleveland public schools, and at the age of sixteen years entered the City Engineer's office, where he steadily advanced until he became Assistant City Engineer, in which capacity he remained for twelve years, having charge of surveys.

While in the service of the city, he surveyed the route of the Superior Street Viaduct, the Kingsbury Run and Central Viaduct, the route of the Walworth Run sewer, and had charge of numerous other public improvements of magnitude and importance. In performing his public duties, no matter how small or trivial the character of his work appeared, he devoted the same strict and careful attention to the slightest details as in matters of great importance, believing that what was worth doing at all was worth doing well.

He was retired on account of the election of a Democratic Director of Public Works in 1893. The same year he was elected County Surveyor of Cuyahoga County by the Republican party and re-elected in 1896. While serving as County Surveyor, he made many improvements in his office, both in records and facilities for work, which have benefited the county and city generally.

He was one of the originators of the Cleveland Civil Engineers' Club, and was an officer of the club for seven years. In August, 1884, he prepared and read before the club a paper entitled, "The Original Surveys of Cleveland," which was published in the journal of the Association of Engineering Societies for that month, with accompanying maps. This paper has since been frequently in demand by surveyors and others interested in the early history and survey of Cleveland.

He has been for many years a member of the Ohio Society of Surveyors and Civil Engineers, and took an active interest in the Society meetings and its welfare. He was an honor to the Society and to the profession.

Mr. Baker died after a brief illness in New York City, October 4, 1899.

REPORT OF THE SECRETARY.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—I have the honor of submitting the following annual report of the Secretary for the Society year from January 17, 1899, to January 23, 1900.

It is my sad duty to announce the death of Dr. Edward Orton, who was for many years an honorary member of the Society.

The nineteenth and twentieth annual reports have been published in one volume and distributed. The exchanges, so far as received, have been distributed to all members who have paid their dues, except to a few who have paid during the last few days. A few other exchanges are yet to be received.

One of our sister societies proposes to publish their report as a quarterly, thus changing to a periodical. This announcement leads me to suggest that a committee be now appointed to consider the matter of publication and to report to this meeting their conclusions in the matter. There are several reasons why our present method is not now entirely satisfactory, although at the time of the organization of the Society it was the best possible arrangement.

The Secretary wishes here to thank the President for his help in the publication of the report, and also to thank all the other members who have rendered aid in various ways.

Respectfully submitted,

C. N. BROWN, *Secretary.*

TREASURER'S REPORT.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—I have the honor of submitting the following as the annual report of the Treasurer for the Society year from January 17, 1899, to January 23, 1900.

RECEIPTS.

Cash on hand January 17, 1899	$ 5 78
Dues for 1898	31 00
Dues for 1899	162 00
Dues for 1900	6 00
Advertisements	152 00
Sale of reports	1 50
Total receipts for 1900	$358 28

EXPENDITURES.

Badges	$ 2 00
Signs, express and sundry expenses at Cincinnati	3 40
Stenographer's report of Cincinnati meeting	55 00
Clerk hire	11 50
Stationery	5 65
Drayage and freight	3 45
Postage	37 75
Paid on printing bill for last report	205 00
Total expenditures for 1900	$323 75
Cash on hand January 23, 1900	34 53
	$358 28

UNPAID BILLS.

Balance on printing bill for last report	$172 91
Printing programs for this meeting	4 40
Total unpaid bills	$177 31

MONEY DUE THE SOCIETY.

Advertisements in last report	$ 23 00
Back dues, estimated at not less than	30 00
Total	$ 53 00

The deficiency in the printing bill is due to two causes. One was the difficulty in securing advertisements, and the other is because two years' papers were printed in this last volume. I think that all can be paid and the report gotten out this year without increasing the dues. I therefore recommend that the annual dues remain at the present amount of $3.00.

Very respectfully submitted,

C. N. Brown, *Treasurer.*

REPORT OF THE TRUSTEES.

The Trustees of the Ohio Society of Surveyors and Civil Engineers beg leave to report as follows:

We have examined the books of the Treasurer and Secretary and find the same to balance, and also to be correct. All moneys received by the Association having been accounted for. We heartily commend the Secretary for the faithful discharge of his duties and fidelity to the Association, and regret that his professional engagements are of such a nature as precludes his serving the Society longer in that position.

We also recommend that a committee of five be appointed by the President, who shall assist the Secretary of the Association in securing advertising matter for the publication of the annual report of the Association.

Respectfully submitted,

J. M. Harper,
J. C. Cronley,
J. B. Weddell.

Columbus, O., Jan. 25, 1900.

To the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—The undersigned, a committee appointed for the purpose of suggesting candidates for the government of the Society, have the honor to submit the following:

For President, Homer C. White.

For Vice-President, J. C. Cronley.

For Secretary and Treasurer, F. J. Cellarius.

Board of Trustees, Prof. C. N. Brown, E. A. Kemmler, Chas. M. Gordon, G. A. McKay and A. W. Jones.

Respectfully,

J. B. Weddell,
C. M. Gordon,
J. M. Harper,
Committee.

CONSTITUTION AND BY-LAWS

OF THE

Ohio Society of Surveyors and Civil Engineers

CONSTITUTION.

ARTICLE I.

This association shall be called the "Ohio Society of Surveyors and Civil Engineers."

ARTICLE II.

Its object shall be the encouragement of professional improvement and good fellowship among its members, by annual meetings for the presentation and discussion of papers on scientific topics, and such other subjects as may be of interest to its members, and the collection of books, maps, and all other articles of value to the engineering profession.

ARTICLE III.

MEMBERSHIP.

SECTION 1. There shall be three classes of members, active, associate and honorary. Only active members are entitled to vote and hold office. In other respects, all members are equally entitled to the privileges of the Society.

SEC. 2. A candidate for active membership must be an engineer, surveyor, architect or scientist, and must have been actively engaged as such for at least three years in a responsible position; but a professional diploma in either department shall be equivalent to two years practice.

SEC. 3. A candidate for associate membership must be qualified by his business relations and practical experience to co-operate with engineers and surveyors in the advancement of professional knowledge, though not himself a practicing engineer, surveyor, architect or scientist. An associate member may take part in the transactions of the Society but shall have no vote.

SEC. 4. Honorary members shall be gentlemen of acknowledged pre-eminence in engineering and surveying, architecture, or applied science.

They shall be subject to neither fees nor assessments.

The number of honorary members shall be limited to ten.

SEC. 5. Any person desiring to become a member of this Society shall fill out a blank application to be provided by the Secretary, who shall present the same, when filled out, to the Board of Trustees, who shall examine the application, and if satisfied that the applicant is eligible, shall recommend him for membership at the same or next annual meeting. All applications shall be returned by the Board of Trustees to the Secretary. No application or nomination for membership shall be entertained by this Society unless endorsed by a majority of the Board of Trustees.

ELECTIONS.

SEC. 6. In elections for membership, members shall vote by ballot, and five or more ballots in the negative shall exclude an applicant from membership. No notice shall be made in the minutes of the Society of the non-election of any applicant.

SEC. 7. On being elected, the applicant shall sign the Constitution and By-Laws, and pay to the treasury an initiation fee of three dollars, after which he shall receive a certificate of membership. If the initiation fee be not paid within six months from notice of election, said election shall be considered void. All members shall sign the Constitution and By-Laws, and are entitled to a certificate of membership.

SEC. 8. Whenever any person is elected to active, associate, or honorary member, the Secretary shall immediately inform him thereof by letter. No person shall be an honorary member unless he signifies his acceptance of membership within six months from the election.

SEC. 9. Every person admitted to the Society shall be considered as belonging thereto, and liable for payment of all assessments until he shall have signified to the Treasurer his desire to withdraw; when, if the Secretary-Treasurer shall show that his dues have been fully paid up, he shall receive an honorable dismissal from the Board of Trustees.

Any member who shall neglect or refuse to pay any assessment for a period of six months, after due notice by the Treasurer has been given, shall cease to be a member. He may be reinstated again by the payment of the amount of the assessment standing against him.

SEC. 10. Any member may, for just cause, be expelled from the Society by a three-fourths vote. No public announcement shall be made of the fact.

DUES.

SEC. 11. The annual dues for active and associate members shall be three dollars, payable in advance at the beginning of each Society year.

ARTICLE IV.

OFFICERS.

Sec. 1. The officers of this Society shall be a President, a Vice-President, a Secretary-Treasurer and a Board of Trustees of five members, all of whom shall be elected from the active membership of the Society, and who shall hold office for one year or until their successors are elected.

Sec. 2. They shall be elected on the second day of each annual meeting, and their term of office shall begin immediately after the closing of the annual meeting at which they are elected. The Society year shall begin at the same time.

Sec. 3. The President shall preside at all meetings of the Society and shall call special meetings at the written request of five members. He shall sign all orders on the Treasurer, and all certificates of membership. In case of failure of appearance at any annual meeting of a quorum of the Board of Trustees, the President shall have power to supply such deficiencies by appointing temporary trustees for the transaction of the official work of such Board during such annual meeting.

He shall be ex-officio member of the Board of Trustees and of all committees, but shall have no vote on said Board and said committees.

The President, with the Secretary and the Board of Trustees, shall arrange the program of exercises for each annual meeting and shall have general care over the affairs of the Society.

A nominating committee of three members shall be named by the President on the second day of each annual meeting.

Sec. 4. The Vice-President shall preside during the absence or at the request of the President. In case of absence of both, a President pro tem shall be elected. The Vice-President shall relieve the President and the Secretary-Treasurer of their official work from time to time as the President shall direct. He shall be an ex-officio member of the Board of Trustees, but shall have no vote in said Board.

Sec. 5. The Secretary-Treasurer shall keep an accurate record of the proceedings of the Society, and enter the same upon the journal when approved. He shall conduct the correspondence of the Society and make a minute of all such correspondence in a book to be provided for that purpose. He shall sign all certificates of membership, shall be an ex-officio member of the Board of Trustees, but shall have no vote in the Board; shall be the custodian of all the Society records; shall deliver all such records or other property of the Society in his possession to his successor, and shall make an annual report, and shall compile and edit the annual report of this Society.

He shall have charge of the funds of the Society and shall give bond with two approved sureties to such amount as may be required from time to time by the Board of Trustees; and his bond

when approved by the Board of Trustees, shall be copied on the journal of the Society and deposited with the President of the Society. He shall pay only such orders as have been signed by the President. He shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor.

SEC. 6. The Board of Trustees shall audit the accounts of the Treasurer and shall examine and report on all applications for membership and the honorable dismissal of members as provided for in Article III, Secs. 5 and 9, and will have a general care over the affairs of the Society as provided in Sec. 3 above.

The Board of Trustees shall provide a place of meeting and give at least twenty days notice to the members of the Society.

STANDING COMMITTEES.

SEC. 7. The President shall appoint at the beginning of each Society year six standing committees of five members each, whose duty it shall be during the year to collate such facts, figures, information and experiments of interest in their respective departments as may be brought to their notice, and make at least one formal report to the Society at the annual meeting following their appointment.

The committees shall be designated as follows and their reports made in the order fixed by the committee on program, viz.;

The Legislative Committee.
Committee on Public Highways.
Committee on Land Surveying and Drainage.
Committee on Civil, Mechanical and Electrical Engineering.
Committee on Instruments and Exhibits.
Committee on Applied Science and Architecture.

Each standing committee shall look after and be responsible to the Board of Trustees for the entire annual literary program under the title of said committee. The chairman of each standing committee shall confer with the chairman of the Board of Trustees as to the character of his particular literary work.

ARTICLE V.

SEC. 1. The Society may provide for the pay of any or all of its officers for their services, whenever deemed advisable.

ARTICLE VI.

SEC. 1. Whenever ten or more members shall signify in writing their desire to form a section of this Society for the advancement of a special branch of engineering, the Board of Trustees shall consider such application, and submit it with an expression of opinion to a regular meeting for a letter ballot.

The application shall be granted if two-thirds of the votes be in the affirmative.

SEC. 2. Such sections shall have the privilege of separate meetings for the reading of papers and discussions, at times and places to be determined by themselves, but may not assume to transact business in the name of the Society.

SEC. 3. The transactions of such sections shall be published by the Society under the usual regulations, but no expense other than for such publications shall be borne by the Society.

ARTICLE VII.

This constitution may be amended at any annual meeting by a two-thirds vote, but shall never be amended so as to be confined to the exclusive use and needs of any one branch of engineering.

BY-LAWS.

SECTION 1. The annual meetings of the Society shall be held in Columbus, Ohio, at any time to be fixed by the Board of Trustees.

Called meetings may be held at any place in Ohio; or any regular meeting may be held at any place other than Columbus, in Ohio, whenever a majority of the members attending the previous meeting may so determine.

SEC. 2. One-fourth of the regular members of this Society shall constitute a quorum.

SEC. 3. All resolutions shall be in writing.

SEC. 4. A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with the name of the donors, shall be entered by the Secretary in a book to be provided for that purpose.

SEC. 5. The Society may by a three-fourths vote, go into secret session for the transaction of business.

SEC. 6. The parliamentary authority for this Society shall be "Roberts' Rules of Order."

SEC. 7. The By-Laws may be amended at any annual meeting by a two-thirds vote.

SEC. 8. No appropriation shall be made of this Society's money, other than for the ordinary current expenses of this Society, without a unanimous vote of the Board of Directors.

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Reports of Ohio Society of Surveyors and Civil Engineers.

FIRST ANNUAL REPORT, 1880.

R. S. PAUL, *President.* B. F. BOWEN, *Vice-President.*
L. B. DENISON, *Corresponding Secretary.*
C. H. BURGESS, *Recording Secretary and Treasurer.*
Columbus, January 15–17.

SECOND ANNUAL REPORT, 1881.

R. S. PAUL, *President.* B. F. BOWEN, *Vice-President*
C. H. BURGESS, *Recording Secretary and Treasurer.*
Columbus, January 12-14.

THIRD ANNUAL REPORT, 1882.

F. J. Sager, *President.* Jonathan Arnett, *Vice-President.*
Benj. Thompson, *Secretary and Treasurer.*
Columbus, January 11-13.

Questions in Practice with Answers.
To Establish a Meridian Line, Prof. R. W. McFarland.
Land Surveying and Its Phases, F. M. Davisson.
Magnetism and Magnetic Variation, Jonathan Arnett.
The Office of County Surveyor, Fred Howell.
Bridges, B. F. Bowen.
Constitution and By-Laws.
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FOURTH ANNUAL REPORT, 1883

F. J. Sager, *President.* Jonathan Arnett, *Vice-President.*
Benj. Thompson, *Secretary and Treasurer.*
Columbus, January 17.

Reorganization, with Constitution and By-Laws.
History of the Office of County Surveyor in Ohio, R. S. Paul.
Improved Roads, S. A. Buchanan
Tenure of Land in Ancient Times, R. W. MeFarland.
Sanitary Engineering, J. B. Strawn.
The Surveyor and Engineer's Mission, Jonathan Arnett.
List of Engineers in Ohio.

FIFTH ANNUAL REPORT, 1884.

J. B. Strawn, *President.* B. F. Bowen, *Vice-President.*
Benj. Thompson, *Secretary and Treasurer.*
Columbus, January 8.

Reports of Committees, very full, especially as to Ditches and Manual.
Address by G. H. Frost.
Origin of the Rectangular System of Surveying, Chas. Whittlesey.
Special Applications in Sanitary Engineering, J. B. Strawn.
Magnetic Declination with Observations in Ohio and Elsewhere, Benjamin Thompson.
Peculiarities of Declination, W. H. Jennings.
Land Drainage, D. W. Pampel.
Field Notes, Their Record and Preservation, R. S. Weitzell.
Surveying Instruments and Their Uses, Francis M. Priest.
Land Surveying, J. D. Varney.
Iron Bridge Connections, John Harvey.
Standards of Measure, T. C. Mendenhall.

SIXTH ANNUAL REPORT, 1885.

(Incorporated January 14, 1885.)

J. B. Strawn, *President*. B. F. Bowen, *Vice-President*.

Benj. Thompson, *Secretary and Treasurer*.

Columbus, January 13-15.

President's Address, J. B. Strawn.
Incorporation—Discussion.
Manual of Surveying, F. Hodgman.
Plate Girder Bridges, Mr. Becker.
Transmission of Power, R. F. Hartford.
Report of Drainage Committee, E. D. Shreve, Chairman.
The Problem of Just Apportionment of the Cost of Ditch Improvements, E. B. Opdyke.
Principles Involved in Making Ditch Estimates and Assessments, J. L. Geyer.
Report of Committee on Land Surveying, J. D. Varney, Chairman.
The Solar Compass in Land Surveys, Geo. R. Gyger.
Report of Committee on Blanks and Instruments, F. M. Priest, Chairman.
The Surveyor and His Field Notes, John L. Culley.
Descriptions in Deeds, R. S. Weitzell.
Sanitary Arrangements in Out Buildings at Mt. Gilead, O., B J. Ashley.
Report of Committee on Civil Engineering, J. H. Holl, Chairman.
Report of Committee on Highways, F. M. Davisson, Chairman.
Charter, Constitution and By-Laws.

SEVENTH ANNUAL REPORT, 1886.

W. H. Jennings, *President*. E. D. Shreve, *Vice-President*.

Benj. Thompson, *Secretary and Treasurer*.

Columbus, January 12-14.

The Use of a Common Datum, with a List of Elevations, Prof. C. N. Brown.
The Geology of Ohio, Prof. Edward Orton.
Report of Drainage Committee, E. D. Shreve, Chairman.
The Problem of Just Apportionment of the Cost of Ditch Improvements, E. B. Opdyke.
Open Drains, Their Size, Grade, Bottom, Width and Bank Slopes, J. S. Ellis.
Landmarks, Ancient and Modern, J. T. Buck.
Land Surveying, G. L. Innis.
Report of Committee on Land Surveying, J. D. Varney, Chairman.
Trials and Tribulations of a Surveyor, Illustrated.
Roads and Canals of Ohio, D. W. Pampel.
Report of Committee on Civil Engineering, R. S. Weitzell, Chairman.
Report of Committee on Blanks and Instruments, W. H. Jennings, Chairman.
Report of Committee on Highways, D. W. Pampel, Chairman.

EIGHTH ANNUAL REPORT, 1887.

W. H. JENNINGS, *President.* D. W. PAMPEL, *Vice-President.*
BENJ. THOMPSON, *Secretary and Treasurer.*
Columbus, January 11-13.

Report of Committee on National Public Works, Benjamin Thompson.
Report of Committee on Legislation, E. B. Opdyke, Chairman.
Preservation of Landmarks, E Sweet, State Engineer, N. Y.
Retrospective and Prospective, F. L. Burrell.
The Oldest Long Span Bridge in Ohio, Chas. B. Cook.
Report of Committee on Land Surveying, J. D. Varney, Chairman.
The Sandusky Water Works, Chas. A. Judson
Bridge Erection, F. J. Sager.
United States Signal Service, E H. Mark.
Report of Committee on Highways, D. W. Pampel, Chairman.
Forecasting Weather, George H. Twiss.
Glade Run Ditch, J. Arnett.
Report of Committee on Drainage, E. D. Shreve, Chairman.
Limits of the Taxing District Under the One Mile Assessment Pike Law, Frank A. Bone.
The Engineer as a Factor in Civilization, E. W. Dimock.
Report of Committee on Blanks and Instruments, E. B. Opdyke, Temporary Chairman.

NINTH ANNUAL REPORT, 1888.

J. D. VARNEY, *President.* E. B. OPDYKE, *Vice-President.*
PROF. C. N. BROWN, *Secretary and Treasurer.*
Columbus, January 10-12.

Report of Committee on Land Surveying, J. D. Varney, Chairman.
Judicial Function of Surveyors, Homer C. White.
Difficulties of Surveying in the Virginia Military Lands, Wm. Reeder.
Adverse Possession, E. D. Haseltine.
Road Making Materials of the State, Prof. Edward Orton.
Notes on Paving, T. R. Wickenden.
Street Pavements in Cleveland, M. E. Rawson.
Street Crossings and Sidewalks, R. A. Bryan.
Monuments, F. Hodgman.
Report of Committee on Highways, D. W. Pampel, Chairman.
The Public Domain, J. T. Buck.
Two Mile Assessment Pike, E. W. Dimock.
Construction of Turnpike, G. L. Innis.
Philosophy of Under Drainage, Jonathan Arnett.
Catfish, Frank M. Kennedy.
The Construction, Comparative Cost, and Efficiency of the Tile Drains and Open Ditches, E. B. Opdyke.
Irrigation in Kansas, J. L. Humphrey.
Report of Committee on Civil Engineering, C. A. Judson, Chairman.

Railroads, Julian Griggs.
Water Supply, C. A. Judson.
The Importance of Water Works and of a Pure Supply of Water for Cities and Villages, J. B. Strawn.
Circleville Water Works, W. C. Row.
Construction, Maintenance and Repair of Short Span Highway Bridges, S. A. Buchanan.
The Calculation of the Strains in the Trusses of Highway Bridges, Prof. C. N. Brown.
Raising and Moving Bridges, Thos. H. Johnson.
Pile Foundations, Julian Griggs.
The Necessity of Piling in County Bridges, F. M. Davisson.
Mortar Making and Using, B. F. Bowen.
Landscape Engineering, John L. Culley.
Outfit of a Railroad Engineering Corps and Conduct of the Survey, Benjamin Thompson.
Railroad Location, S. F. Rock.
Duplication of Drawings, Joseph N. Bradford.
Report of Committee on Blanks and Instruments, E. D. Haseltine, Chairman.
The Use of Steel Tapes in Surveying, J. B. Johnson.

TENTH ANNUAL REPORT, 1889.

B. F. Bowen, *President.* H. C. White, *Vice-President.*
C. N. Brown, *Secretary.* F. J. Sager, *Treasurer.*

Columbus, January 8–10.

Maps for the Use of Assessors; Report of a Committee and Discussion.
Report of Committee on Land Surveying, J. B. Strawn, Chairman.
The Importance of Properly Making Surveys, Homer C. White.
Water Supply, C. A. Judson.
Bridge Engineering During 1888, A. J. Lewis.
Municipal Engineering, Thomas R. Wickenden.
Street Pavements, Sam. Huston.
Limes and Cements of Ohio, Dr. Orton.
Pile Protection, J. A. Pritchard.
A Curved Dam, ——
Country Parks and Cemeteries, John L. Culley.
Water Supply Difficulties, H. F. Dunham.
Description of a Sewer, H. L. Weber.
Mote Ditch, F. M. Davisson.

ELEVENTH ANNUAL REPORT, 1890.

J. T. Buck, *President.* Julian Griggs, *Secretary and Treasurer.*

County Surveyors and the Law Under Which They Work, W. E. Peters.
Condition and Needs of the Engineering Profession in Ohio, Samuel Bachtell.

The Operations of the Coast and Geodetic Survey, Prof. T. C. Mendenhall, Washington, D. C.
Water Works for Towns and Villages, J. B. Strawn.
Rural Water Supply, Its Condition and Needs, J. Arnett.
Natural Gas, H. L. Weber.
City Streets, How to Build Them and Why, L. W. Mathewson.
The Attempt to Build the First Free Turnpike in Tuscarawas County, W. M. Ray.
Maintenance of Way on Railroads, A. W. Jones.

TWELFTH ANNUAL REPORT, 1891.

THOS. R. WICKENDEN, *President*. SAM'L BACHTELL, *Vice-President*.
E. D. WILEMAN, *Secretary and Treasurer*.

Columbus, January 20-22.

President's Address.
Report of Committee on Legislation; a proposed bill to define what shall constitute a legal description of land.
A proposed bill to establish a uniform system of time throughout the State of Ohio.
Report of Committee on Civil Engineering, C. A. Judson and J. L. Culley.
Report of Committee on Land Surveying, J. D. Varney, Chairman.
Report of Committee on Highways, Thos. R. Wickenden, Chairman.
Report of Committee on Blanks and Instruments.
Methods and Results of Railway Surveying in South Australia, E. D. Wileman.
The Louisville Southern Railroad and Its Branches, with Notes on Construction, S. F. Rock.
What Knowledge Shall Be Required of a Man to Practice Surveying or Engineering, Prof. C. N. Brown.
Land Surveying, G. S. Innis.
Transit Points, John L. Culley.
The Separate System of Sewers as Proposed for the City of Dayton, Ohio, F. J. Cellarius.
Notes on the Construction of Sewers, Chas. A. Judson.
Separate System of Sewers, J. B. Weddell.
Permanent Drainage, D. W. Seitz.
Lecture, Prof. Edward Orton.
Improvement and Protection of Domestic Water Supplies, J. B. Strawn.
Brick and Brick Pavements for City Streets, E. B. Shifley.
Substructure for Bridges, W. K. Liggett.
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THIRTEENTH ANNUAL REPORT, 1892.

C. H. Burgess, *President.* L. W. Mathewson, *Vice-President.*
Chas. A. Judson, *Secretary and Treasurer.*
Columbus, January 19–21.

President's Address, Thos. R. Wickenden.
The County Surveyor, John C. Grim.
Some Practical Experience in Land Partition, S. F. Rock.
Record of Surveys, D. W. Seitz.
Platting Town Lots, Geo. M'Gormley.
Conveyancing, W. E. Peters
Survey of the Boundary Lines Between Ohio and Indiana and Ohio and Michigan, Mr. Graham.
The Annual Change in the Declination of the Magnetic Needle: Is It a Constant Quantity? E. W. Dimock.
Details in Ditch Location, A. D. Sheldon.
County Ditch Assessments, Homer C. White.
Artificial Stone in Construction, Samuel Bachtell.
Width of Paved Roadway in City Streets, S. Whinery.
The Muskingum River Bridges, T. C. Connar.
The Jacksonville (Florida) Bridge, O. Benson.
Improvement of County Roads, Their Necessity, G. S. Innis.
Turnpike Specifications for Newtonsville and Boston Free Turnpike, Clermont County, Ohio, Geo. H. Hill.
Report of Committee on Highways, J. B. Weddell, Chairman.
Report of Committee on Surveying, J. T. Buck, Chairman.
Report of Committee on Drainage, F. M. Davisson, Chairman.
Report of Committee on Civil Engineering, J. B. Strawn, Chairman.
Report of Committee on Blanks and Instruments, L. W. Mathewson, Chairman.
Report of Committee on Legislation, Prof. C. N. Brown, Chairman.
Report of Special Committee on Preparing a Bill Requiring Surveyors to be Licensed, C. H. Burgess, T. R. Wickenden, Prof. C. N. Brown, Committee.
State Directory of Surveyors and Civil Engineers.

FOURTEENTH ANNUAL REPORT, 1893.

John B. Weddell, *President.* J. M. Harper, *Vice-President.*
Chas. A. Judson, *Secretary and Treasurer.*
Columbus, January 17–19.

President's Address, C. H. Burgess.
Observations on the Magnetic Needle and Magnetic Variations, Prof. T. C. Mendenhall.
On Location of County Roads, T. F. Brown.
How I Make a Survey, Elmer E. Harvey.
Some Steel Tape Records from the Correspondence of C. H. Burgess.
Method of Correction for Random Line, Geo. H. Hill.

FIFTEENTH ANNUAL REPORT, 1894.

J. M. HARPER, *President.* H. C. WHITE *Vice-President.*
CHAS. A. JUDSON, *Secretary and Treasurer.*

Cleveland, January 16–19.

Hoist Bridge Across the Miami Canal at Keowee Street, Dayton, Ohio, G. R. Stattlemann.
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Report of Committee on Civil Engineering, John L. Culley, Chairman.
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Report of Committee on Drainage, E. L. Spafford, Chairman.
Report of Committee on Land Surveying, very extended report.
How Best to Employ the Time Allotted for Annual Meeting, F. P. Burt.
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Letter from Benj. Thompson.
Letter from A. A. Graham in regard to boundary lines of Ohio.
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SIXTEENTH ANNUAL REPORT, 1895.

J. L. CULLEY, *President*. F. M. TURNER, *Vice-President*.
CHAS. A. JUDSON, *Secretary and Treasurer*.

Cincinnati, January 15–18.

Address of Welcome, Mayor Caldwell of Cincinnati.
President's Annual Address, J. M. Harper.
Garbage Disposal in Small Towns and Villages, Latham Anderson, M. Am. S. C. E.
A Solution of the Road Problem, Hon. Martin Dodge.
Methods of Road Construction in Vogue in Warren Co., O., F. A. Bone.
Sidewalks, Homer C. White.
Practical Notes on Concrete, S. B. Newberry.
Address of M. D. Burke, President of Engineers Club of Cincinnati.
Some of the Engineering Features of Cincinnati, H. J. Stanley.
The Uses of Electricity in Railroad Signalling, E. D. Wileman.
Comments on the Ohio Ditch Law, E. B. Opdyke.
Report of Drainage Committee, Jas. C. Wonders, Chairman.
Riparian Rights, J. A. Hanlon.
Report of Committee on Solar Attachments.
Surveying by Photography, Prof. E. A. Kemmler.
Report of Committee on Surveying, Hosea Paul.
Supplementary Report, J. S. Sill.
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SEVENTEENTH ANNUAL REPORT, 1896.

J. B. Davis, *President.* E. F. Layman, *Vice-President.*
Prof. C. N. Brown, *Secretary and Treasurer.*

Dayton, February 25-27.

Address of Welcome, Mayor C. G. McMillen.
President's Annual Address, F. M. Turner.
Improvement at Street Intersections, H. W. M'Donald.
Portland Cement-Lime Mortar, S. B. Newberry.
Some Tests of Natural Cement, I. C. Brewer.
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Report of Committee on Civil, Mechanical and Electrical Engineering, F. M. Lillie.
Random Notes, H. L. Weber.
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Sewage Disposal, Geo. H. Frost.
Sewer Records, Homer C. White.
Some Notes on a Combined Water Works and Electric Light Plant, J. B. Strawn.
Some Features of the Port Clinton Water Works, C. E. Dewitt.
A New Solar Transit, J. B. Davis.
A Timber Trestle, Chas. A. Judson.
Notes on a Recent Drainage Decision, E. B. Opdyke.
Suggestions for Improvement, Benjamin Thompson.
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EIGHTEENTH ANNUAL REPORT, 1897.

G. S. Innis, *President.* F. J. Cellarius, *Vice-President.*
Prof. C. N. Brown, *Secretary and Treasurer.*

Columbus, January 18-20.

President's Annual Address, J. B. Davis.
Report of Committee on General Engineering, Prof. J. L. Gilpatrick.
The Work of the County Engineer, J. C. Cronley.
The Floor System of Highway Bridges.
Strict Integrity a Necessary Qualification of the Engineer, J. B. Strawn.
Report of Committee on Legislation, J. D Varney.
Some of the Benefits of Our Engineers Association, E. B. Opdyke.
The Triangle: What is It, and What Its Relation to Mathematical Science, Jonathan Arnett.
Section Lines and County Boundaries, Prof. R. W. McFarland.
The Torrens Law, Hosea Paul.

NINETEENTH ANNUAL REPORT, 1898

PROF. J. L. GILPATRICK, *President.* E. A. KEMMLER, *Vice-President.*
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Columbus, January 17–19.

TWENTIETH ANNUAL REPORT, 1899.

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Cincinnati, January 18-20.

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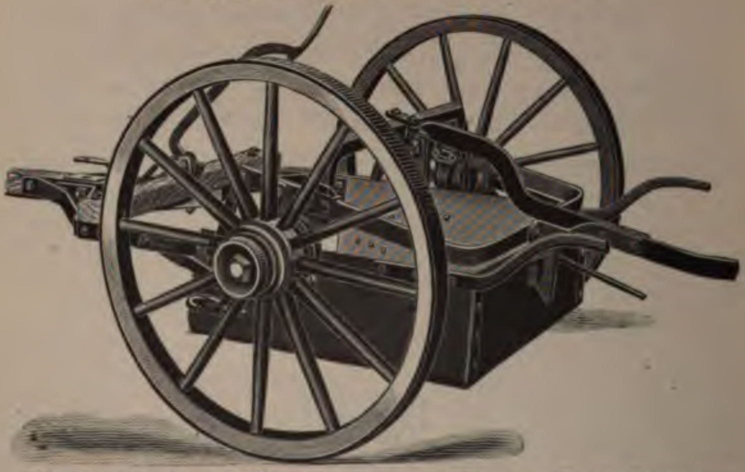

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Broomhall, Burt	Surveyor	Spencers	Guernsey
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Brown, George	Draughtsman City Engineer's Office.	Toledo	Lucas
Brown, Hiram	Surveyor	Urbana	Champaign
Brown, J. A	City Engineer	Wilmington	Clinton
Brown, Jay F	Civil Eng. and Contractor	Cleveland Cuyahoga Building.	Cuyahoga
Brown, J. R. C	Assistant City Engineer	Gallipolis	Gallia
Brown, W. F	City Engineer	Toledo	Lucas
Brumbaugh, W. D	City Engineer	Greenville	Darke
Brunch, F. F	Surveyor	Elyria	Lorain
Bryan, R. A	City Engineer	Portsmouth	Scioto
Buck, John T	Civil Engineer and Surv'or	Cardington	Morrow
Buck, Thad. E	County Surveyor	Mt. Gilead	Morrow
Buell, C. W	Civil Engineer and Surv'or	Toledo 2052 N. 14th St.	Lucas
Buell, James K	Surveyor	John'nville	Trumbull
*Burgess, Clarence H	Civil Eng. and Contractor	Cleveland 89 Euclid Ave.	Cuyahoga

Burke, M. D.	Civil Engineer.	Cincinnati	Hamilton
		404 Pike Bldg.	
Butler, J. H.	County Surveyor-elect.	Peebles	Adams
Butts, W. H.	Ass't Eng. B. & O. R'y.	Cincinnati	Hamilton
Buxton, C.	Chief Eng. T. & O. C. R'y.	Toledo	Lucas
Cafferty, H. L. M.	Civil Engineer and Surv'or.	London	Madison
*Cantrell, G. W.	Civil Engineer and Surv'or.	Brooklyn	Cuyahoga
Carlisle, W. A.	Civil Engineer.	Coshocton	Coshocton
Carothers, D. D.	Civil Engineer, Dept. M. of W., B. & O. R'y.	Cincinnati	Hamilton
Carpenter, E. J.	Assistant U. S. Engineer.	Cincinnati	Hamilton
		Government Bldg.	
Carson, Irvin	Assistant City Engineer.	Chillicothe	Ross
Carter. Wm. J.	Ass't City Eng., Sewers.	Cleveland	Cuyahoga
Cartwright, J. S.	City Engineer.	Ottawa	Putnam
Cassil, A.	City Engineer.	Mt. Vernon	Knox
Cassil, N. H.	Civil Engineer.	Mt. Vernon	Knox
*Cellarius. F. J	Assistant City Engineer.	Dayton	Montgomery
		Room 8, City Bldg.	
Chamberlain, L. W.	Civil Engineer and Surv'or.	Marietta	Washington
Chamberlin, John R.	Civil Engineer (at O. S. U.).	Tiffin.	Seneca
Chapin, L. E.	Civil Engineer.	Canton	Stark
Chase, R. D.	Civil Engineer and Surv'or.	Sandusky	Erie
Cobb, Fred	Civil Engineer.	Akron	Summit
Cole, Glen G.	County Surveyor.	Holmesville	Holmes
Cole, J.	County Surveyor.	Ravenna	Portage
Collins, R. G.	Civil Engineer.	Zanesville	Muskingum
Conklin, Frank	Civil Engineer and Surv'or.	P't Jeff'son	Shelby
Consaul, Frank I.	Assistant City Engineer.	Toledo	Lucas
Converse, H. J.	Civil Engineer and Surv'or.	Plain City	Madison
Conway, H. L.	Ass't Eng. Water Works.	Cincinnati	Hamilton
		2510 Hemlock St.	
Cook, J. D.	Civil Engineer and Surv'or.	Toledo	Lucas
		56 Law Bldg.	
Cooke, Edward C.	Engineer Water Works.	Cleveland	Cuyahoga
		822 Soc. for Sav. Bldg.	
Cormar, H. L.	Ass't Eng. B. & O. R'y.	Zanesville	Muskingum
Cormar, T. C.	Civil Engineer and Surv'or.	Zanesville	Muskingum
Corns, H. C.	Civil Engineer and Surv'or.	Ironton	Lawrence
Correll, E. J.	Ass't Eng. B. & O. R'y. Ohio Division.	Chillicothe	Ross
Coryell, W. C.	Civil Engineer and Surv'or.	W. Union	Adams
Counts, Charles	Ex-County Surveyor.	P't Jeff'son	Shelby
Cowen, Clinton	Surveyor.	Cincinnati	Hamilton
		540 Main St.	
Cox, James L.	Deputy County Surveyor.	Brilliant	Jefferson
Craig, Richard.	Ex-County Surveyor; Civil and Mining Engineer.	McArthur	Vinton

*Craig, Samuel	County Surveyor and Eng.	Wapak'eta.	Auglaize
Cramer, Chas	Civil Engineer and Surv'or.	Shade	Athens
Cronin, S. L.	County Surveyor	Woodsfield	Monroe
*Cronley, J. C.	County Surveyor and Civil Engineer.	Lima	Allen
Cully, Fred S	County Surveyor	Newark	Licking
Cully, John L.	Civil Engineer	Cleveland. 33 Blackstone Bldg.	Cuyahoga
Curfman, Samuel	City Engineer	Steub'ville.	Jefferson
Curtis, L. G.	Dept. M. of W., B & O. R'y.	Zanesville.	Muskingum
Danenhower, C. N.	Civil Engineer	Cincinnati. 1215 Jackson St.	Hamilton
Danford, B	County Surveyor-elect	Whigville	Noble
Darst, B. F.	Civil Engineer and Surv'or.	Shoups Sta	Greene
Davis, C. B	Assistant City Engineer	Cambridge	Guernsey
*Davis, Chas S	Civil Engineer and Surv'or.	Toledo	Lucas
*Davis, Jno. B	Civil Engineer and Surv'or.	Cleveland. 242 The Arcade.	Cuyahoga
Davis, J. D	Ex-County Surveyor	Chest'r Hill.	Morgan
Davis, M. L	Civil Engineer	Lisbon	Columbiana
Davis, Solon	Civil Engineer and Surv'or.	Weston	Wood
Davis, W. L.	Civil Engineer and Surv'or.	Ironton	Lawrence
*Davisson, F. M.	Civil Engineer and Surv'or.	W. Manch'r.	Preble
Dawley, W. M.	Ass't Eng. B. & O. R'y.	Cincinnati.	Hamilton
*Delbitt, Chas. E.	Civil Engineer and County Surveyor.	P't Clinton.	Ottawa
*DeMotte, R. K	County Surveyor and Civil Engineer.	Eaton	Preble
*Denison, L. B.	Civil Engineer and Surv'or.	Delaware	Delaware
Dennick, Ed	Draftsman, Mt. Vernon Bridge Co.	Mt. Vernon.	Knox
Dercum, Otto	Civil Engineer and Surv'or.	Cleveland. 362 Sibley St.	Cuyahoga
Derrickson, Geo. M.	Civil Engineer and Surv'or.	Akron	Summit
Devereux, H.	Resident Eng. B. & O. R'y.	Cincinnati.	Hamilton
Devore, L. N.	Engineer Bellefontaine Bridge Co.	Bellef'taine	Logan
Dick, H. B.	Chief Eng. P. & L. K. R'y.	Zanesville.	Muskingum
Dickens, E.	Civil Engineer and Surv'or.	Pedro	Lawrence
*Dickey, E. P.	City Engineer	Warren	Trumbull
Dickinson, L. A	Civil Engineer and Surv'or.	Fremont	Sandusky
Diemar, C. R.	County Surveyor-elect	Ironton	Lawrence
Dike, J. S.	Deputy County Surveyor	Delaware	Delaware
*Dillon, L. A.	County Surveyor and City Engineer.	Hamilton	Butler
Dimock, E. W	Civil Engineer and Surv'or.	Dupont	Putnam
Dixon, J. R.	Civil Engineer and Surv'or.	Orwell	Ashtabula
Doak, A. S.	County Surveyor	Winchester.	Adams

Doane, L. W.........Civil Engineer and Surv'or. Zanesville..Muskingum
Donham, David.......Civil Engineer and Surv'or. Lindale.....Clermont
Donnelly, J. F.........Deputy County Surveyor...Montpelier . Williams
Doty, Frank.........City Engineer..............Middl'town. Butler
Doty, Geo...........Civil Engineer and Surv'or. Edon.......Williams
Dougan, J. F.........Ex-County Surveyor.......Pennsville..Morgan
*Dowler, J. W.......County Surveyor...........Troy ....Miami
Dowling, Jos. L......Civil Engineer Buckeye....Lima. .....Allen
Pipe Line Co.
Dowson, W. C. .....Civil Engineer.............Cincinnati..Hamilton
2617 Cleinview Ave.
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Dunn, J. J...........Civil Engineer.............Columbus..Franklin
*Dunn, Wm...........County Surveyor...........Zanesville..Muskingum
Dwyer, Geo. H...... Assistant City Engineer....Marion.....Marion

Earnshaw, Joseph ...Civil Engineer and Surv'or. Cincinnati ..Hamilton
Glenn Bldg.
Eberhard, Julius.....City Engineer.............Wooster....Wayne
Edwards, E. M.......Civil Engineer and Surv'or. Cleveland ..Cuyahoga
1309 Cedar Ave.
Egerton, J. T.... ...County Surveyor...........Ironton.....Lawrence
Eldridge, Wm ....Surveyor..................Bartlett..... Washington
Eldridge, J. J........Surveyor..................Bartlett..... Washington
Ellis, Jeremiah .....(From Adams Co., O.)......Concord, Ky.
Ells, Wm. B.........Civil Engineer... ....Mt. Gilead..Morrow
English. D. H. ......Surveyor .. ..Defiance....Defiance
Engle, Robert L......Civil Engineer and Surv'or. Cincinnati..Hamilton
1530 Lincoln Ave.
Eno, Frank H ....Ch. Draftsman.............Columbus..Franklin
Dep. Pub. Imp.
Estep, E. J...........Ass't City Eng., Surveys....Cleveland ..Cuyahoga
*Evers, Wm. H......County Surveyor...........Cleveland ..Cuyahoga

Faist, J. E.......... Civil Engineer.............Hamilton...Butler
Farmer, I. P.........Ex. County Surveyor ..... Lisbon .....Columbiana
Farbell, J. D.........Civil Engineer and Surv'or. Bedford ....Cuyahoga
Fauver, Lester.......County Surveyor...........Elyria......Lorain
Fawcett, Joseph .....Civil Engineer...... .. ..Carrollton..Carroll
Fawcett, John . .....Civil Engineer.............Kilgore.....Carroll
Fawcett, Oscar.......Surveyor..................Walnut Grove, Logan
Felter, Geo. W.......Civil Engineer and Surv'or. Williamsburg, Clermont
Fenton, B. W........Eng. M. of W. C. P. & V. Ry. Cincinnati ..Hamilton
Ferris, A. J..........Surveyor..................Cincinnati..Hamilton
429 Pike Bldg.
Fiedler, W. T. F.....Ass't Eng. B. & O. R. R....Cincinnati..Hamilton
Fishbaugh, A. W....Co. Sur. and City Eng......Celina......Mercer
*Fischer, E. H.......Civil Engineer and Surv'or. Lockbourne. Franklin

Fisher, A. M	Civil Engineer and Surv'or	Coshocton	Coshocton
Fisher, J. E.	Civil Engineer and Surv'or	Bowling Green,	Wood
Fitzgerald, J.	Civil Engineer and Surv'or	Conneaut	Ashtabula
Fitzpatrick, Andrew	Civil Engineer	Fayetteville	Brown
Flickinger, H. V.	County Surveyor.	Bucyrus	Crawford
Force, John P.	Civil Engineer and Surv'or	Cleveland	Cuyahoga
		504 Society for Sav. Bldg.	
Force, John P.	Ass't Eng. Dep't Pub. Imp	Columbus	Franklin
Ford, Collin, Jr.	Civil Engineer	Cincinnati	Hamilton
		413 Vine St.	
Fout, Lafayotte	Surveyor	Portsmouth	Scioto
Flynn, B. H.	Eng. Ohio State Board of Health.	Columbus	Franklin
Fox, H. S.	Civil Engineer and Surv'or	Brookville	Montgomery
Fox, Al	Civil Engineer and Surv'or	Dayton	Montgomery
		25 N. Main St.	
Fox, W. S	Surveyor	Shortcreek	Harrison
Fox & Goodspeed	Mining Engineers	Nelsonville	Athens
Flanigan, C. E.	Civil Engineer and Surv'or	Steubenville,	Jefferson
*Fraker, L. B	County Surveyor	Bowling Green,	Wood
Frank, Ernest	Surveyor	Oak Harbor	Ottawa
Franklin, Byron	County Surveyor	Wilmington	Clinton
Frazier, T. J	Ass't Eng. B. & O. R. R.	Zanesville	Muskingum
French, Morris	City Engineer	Salem	Columbiana
Fullerton, A. L.	Architect and Civil Engin'r	Chillicothe	Ross
Galvin, Archie J.	Ass't City Engineer	Cleveland	Cuyahoga
		128 Franklin Ave.	
Gamble, R. H.	City Engineer	Lima	Allen
Ganyard, L B.	County Surveyor	Medina	Medina
Garber, John M.	Draftsman Mt. Vernon Bridge Co.	Mt. Vernon	Knox
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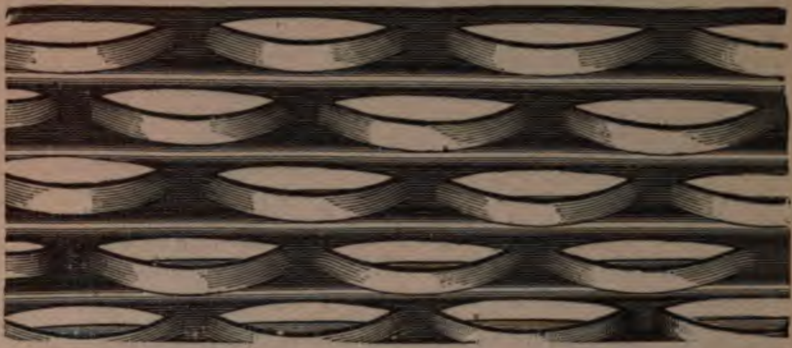
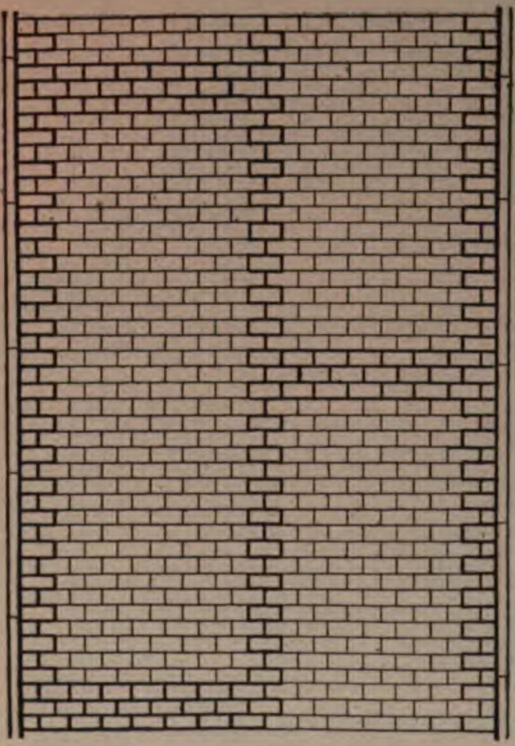
Garrett, George M	Civil Engineer and Surv'or	Cleveland	Cuyahoga
		140 Alanson St.	
*Gates, H. M	Civil Engineer	Columbus	Franklin
		23½ N. High St.	
Gates, E. Frank	City Engineer	Marietta	Washington
Gates, C. L	Eng. Toledo Bridge Co.	Toledo	Lucas
Gault, Homer J.	Civil Engineer and Surv'or	Cleveland	Cuyahoga
		17 Lake Ave.	
Geddes, George	Surveyor	Hoskinsville,	Noble
Geddes, J. K.	Chf. Eng B. Z. & C. R. R.	Zanesville	Muskingum
Gellitle, W. E.	Civil Engineer and Surv'or	Clyde	Sandusky
George, John A	City Engineer	E. Liverpool,	Columbiana
*Gerrish, Wm. B.	City Engineer	Oberlin	Lorain
Gessner, G. A.	Ass't City Engineer	Toledo	Lucas
Giessen, Charles H.	Civil Engineer and Surv'or	Cleveland	Cuyahoga
		20 Blackstone Bldg.	



Gilbert, ——.........Surveyor..........Venice, Ross P. O...Butler
*Gillett, M. M.......Civil Engineer.............Newark....Licking
*Gilpatrick, J. L.....Prof. of Civil Engineering..Granville...Licking
Denison University.
Ginn, W. A..........County Surveyor..........Bellefontaine, Logan
Glasgow, W. R.......Civil Engineer and Surv'or.Shiloh......Richland
Glathart, H. A.......Civil Engineer and Surv'or.Findlay.....Hancock
Goldfogle, David.....Civil Engineer............Cincinnati..Hamilton
Dennison Hotel.
Good, Charles W. B..Assistant Engineer...........Ashland....Ashland
Good, Emery H......Deputy County Surveyor...Tiffin.......Seneca
Goodell, R. S.........Prin. Ass't Engineer......Mt. Vernon.Knox
Mt. Vernon Bridge Co.
Goodspeed & Fox....Mining Engineers..........Nelsonville.Athens
*Gordon, C. M......County Surveyor............Georgetown.Brown
Gordon, H. J........Surveyor..................Oak Harbor.Ottawa
Graf, Edwin.........Assistant City Engineer....Canton.....Stark
Graham, E. E........Draftsman Morgan Eng.Co.Alliance....Stark
Graham, Alva......Surveyor..................Marysville..Union
Greek, Jacob........City Engineer.........Upper Sandusky..Wyandot
Griffin, O. U.........Civil Engineer and Surv'or.Fayette.....Fulton
(P. O. Morenci, Mich.)
Green, B. J..........County Surveyor..........Cadiz.......Harrison
Griggs, Julian......Chief Engineer............Columbus..Franklin
Dep Public Improvements.
Grim, John C.......Civil Engineer and Surv'or.Bryan......Williams
*Groves, John W....Instructor O. S. U..........Columbus..Franklin
212 W. 10th Ave.
*Gyer, George R.....Civil Engineer and Surv'or.Alliance....Stark

*Hanlon, John A....City Engineer.............Coshocton..Coshocton
*Hanlon, Wm. B.....Civil Engineer and Surv'or.N. Phil'del'a, Tuscarawas
Harlan, B. H.........Civil Engineer and Surv'or.Lima......Allen
Lima Steel Co.
*Harper, J. M........Civil Engineer............Cincinnati..Hamilton
1546 Baymiller St.
Harrison, B. W......County Surveyor..........Cincinnati..Hamilton
Court House.
Harvey, E. E.........City Engineer.............London.....Madison
Harvey, John........Assistant County Engineer Hamilton...Butler
*Harvey, Lanson B...Civil Engineer and Surv'or.Marysville..Union
*Haseltine, Edwin D.Civil Engineer and Surv'or.Youngsto'n.Mahoning
Haseltine, Robt. M...Civil Engineer and Surv'or.Youngsto'n.Mahoning
Hatcher, John D.....Civil Engineer and Surv'or.Forest Dale.Lawrence
Hatcher, W. B. G....Civil Engineer and Surv'or.Sheridan...Lawrence
Coal Works.
Hayward, G. E......County Surveyor...........N. Phil'del'a, Tuscarawas
Heller, A. H.........Chief Eng. Youngstown....Youngsto'n.Mahoning
Bridge Co.

Henderson, Jno. C.	Surveyor	Archer	Harrison
Henretta, C. M.	Mining Engineer	Cambridge	Guernsey
Hewitt, B. F.	Civil Engineer and Surv'or	Conneaut	Ashtabula
Heyl Brothers	Surveyors	Cincinnati	Hamilton
	N. E. cor. Hopkins and Linn.		
Hibbard, S. H.	County Surveyor	Athens	Athens
Hibbs, Wm	Mining Engineer	Scio	Harrison
*Hill, Geo. H	Civil Engineer and Surv'or	Milford	Clermont
Hill, John W	Civil Engineer	Cincinnati	Hamilton
		35 Glenn Bldg.	
Hoadley, J. S.	County Surveyor	Bryan	Williams
Hobby, Arthur S.	Civil Engineer	Cincinnati	Hamilton
		33 Wiggin's Block.	
Hochenedel, C. A.	Civil Engineer and Surv'or	Fremont	Sandusky
Hoffman, C	Surveyor	Doyl'stown	Wayne
Hofman, Joseph	Civil Engineer and Surv'or	Toledo	Lucas
		3118 Cherry St.	
Hoge Ernest	Surveyor	Guernsey	Guernsey
Hoge, O. M	City Engineer	Cambridge	Guernsey
Holl, J. H.	Civil Engineer	Canton	Stark
Hollister, G. G.	Surveyor	Dunhan	Washington
Holton, H. S.	Assistant Engineer Dept. of Public Improvements.	Columbus	Franklin
Holtz, L. E.	Civil Engineer and Surv'or	Ottawa	Putnam
Hood, Robt	Civil Engineer and Surv'or	Cedarville	Green
Hoover, J. S.	County Surveyor and Civil Engineer.	Canton	Stark
Hosbrook, D. S.	Surveyor	Cincinnati	Hamilton
		65 Pickering Bldg.	
Hosbrook, J. Asa	Surveyor	Cincinnati	Hamilton
		429 Pike Bldg.	
Houglin, G. M.	Deputy County Surveyor	Paulding	Paulding
House, J. E.	County Surveyor and City Engineer.	Sidney	Shelby
*Howe, Chas. S.	Prof. Mathematics and Astronomy, Case School of Applied Sciences.	Cleveland	Cuyahoga
Howison, Earl.	Civil Engineer and Surv'or	Warrensburgh	Delaware
Hoyt, Geo. M.	Surveyor	Perry	Lake
Hoyt, M. B.	Ex-County Surveyor	Delta	Fulton
Huddle, J. D.	County Surveyor	Ottawa	Putnam
Hudson, D. P.	Deputy County Surveyor and Civil Engineer.	Napoleon	Henry
Hudson, W. O.	Civil Engineer and Surv'or	Napoleon	Henry
Huge, E. W.	Surveyor	Cincinnati	Hamilton
	S E. cor. Ninth and Vine Sts.		
Hughes, Henry	County Surveyor and City Engineer.	Fremont	Sandusky
Hughes, ——	Assistant City Engineer	Niles	Trumbull
Hunt, H. E.	County Surveyor	Jackson	Jackson
Huntington, E.	Civil Engineer and Surv'or	Painesville	Lake



Husey, Geo. D.......Civil Engineer.............Youngsto'n.Mahoning
*Huston, Sam.. .....County Surveyor...........Steub'ville..Jefferson
Hutchinson, C. E....Deputy County Surveyor...Kenton.....Hardin
Hutson, A. V........Civil Engineer and Surv'or.Bent'nville.Adams
Hyde, A. Lincoln....Civil Engineer and Surv'or.Cleveland..Cuyahoga
New England Bldg.

*Jackson, E. S.......Surveyor..................Elyria......Lorain
Jacobs, Bert.........Deputy County Surveyor...Wash'gton C.H., Fayette
Jacobs, D. R.........County Surveyor...........Wash'gton C.H., Fayette
Jenkins, Henry W...Civil Engineer and Surv'or.Portsmo'th.Scioto
1175 Grandview Ave.
Jenkins, W. H.......Transit Man P. C. C. &....Columbus..Franklin
St. L. R'y.
Jewett, D. S.........Civil Engineer.............Cincinnati..Hamilton
2527 Gilbert Ave.
Johnson, A..........Surveyor..................Paint Valley, Holmes.
Johnson, S. A........County Surveyor...........Racine.....Meigs
Johnson, W. H......Civil Engineer and Surv'or.Barberton..Summit
Johnson, W. J.......County Surveyor...........Paulding...Paulding
*Jones, A. W........County Surveyor and Eng..Chillicothe.Ross
C. Mt. S. & C. Electric R'y.
Jones, Lafayette.....County Surveyor and Eng..Portsmo'th.Scioto
Jones, Shannon......Civil Engineer and Surv'or.Jerusalem..Monroe
Jonte, P. N..........Surveyor..................Cincinnati..Hamilton
Room 3, No. 134 E. Court St.
Judson, A. W........County Surveyor..........Sandusky...Erie
*Judson, C. A........Civil Engineer....... .Sandusky...Erie

Kaney, J. G.........Civil Engineer and Surv'or.Toledo......Lucas
335 Superior St.
*Kearfott, Wm. D....Manager for...............Cleveland..Cuyahoga
H. R. Worthington.
Keenan, Emmet.....Surveyor.................Batesville...Noble
Keith, John.........Surveyor ....Spencerville.Allen
Kelly, J. C...........Civil Engineer.............E. Liverpool.Columbi'na
*Kemmler, E. A. ...Civil Engineer and Surv'or.Columbus..Franklin
Kemper, W. R.......City Engineer..............Lebanon....Warren
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Kennedy, J. C.......County Surveyor and City..Marysville..Union
Engineer.
Kennon, D. C........Civil Engineer.............Barnesville.Guernsey
Keuthan, Ferd.......City Engineer..............St. Marys...Auglaize
Kimble, W. P........Eng. M. of W. Cincinnati...............Crawford
Division Erie R'y.
King, S..............Assistant City Engineer....Youngsto'n.Mahoning
Kingsley, M. W......Sup't Water Works........Cleveland..Cuyahoga
*Kinnear, Josiah.....Civil Engineer.............Columbus..Franklin
652 E. Long St.

Kirk, Eugene........Civil Engineer and Surv'or. Youngsto'n. Mahoning
Kirkwood, S. J.......Professor of Mathematics...Wooster....Wayne
Wooster University.
Kline, Chas..........Deputy County Surveyor...Dayton.....Montgomery
Court House.
*Kline, Robt. E .....County Surveyor. ....Dayton.....Montgomery
Court House.
Knepp, Henry.......Surveyor..................Creston.....Wayne
Knorr, H. E.........Assistant County Engineer. Cincinnati..Hamilton
Court House.
Knouff, O. M........Civil Engineer.............Caldwell...Noble
Koehler, Nicholas....Deputy County Surveyor...Columbus..Franklin
Kolbe, Henry........Civil Engineer and Surv'or. Napoleon...Henry
Krause, Frank B.....Civil Engineer and Surv'or. Cleveland..Cuyahoga
Society for Savings Bldg.
Krause, Frank L.....Civil Engineer and Surv'or. Cleveland..Cuyahoga
Society for Savings Bldg.
Kritzinger, H. B.....Surveyor.................Paulding...Paulding
Krug, F. S...........County Engineer.........Cincinnati..Hamilton
Court House.
Kurz, Wm. A........Civil Engineer and Surv'or. Cleveland..Cuyahoga
504 American Trust Bldg.

Laird, Ed.........Assistant City Engineer....Tiffin.......Seneca
Columbia St.
Laird, Jacob.........City Engineer.............Mansfield..Richland
Lakeman, W.........Civil Engineer............Cincinnati..Hamilton
4310 Beech Hill Ave.
*Lander, Frank R....County Draftsman..........Cleveland..Cuyahoga
321 Marcy Ave.
Lane, J. D...........County Surveyor and City..Carrollton..Carroll
Engineer.
Large, J. H.........Civil Engineer............Whigsville..Noble
*Laylin, Jno........County Surveyor and City..Norwalk....Huron
Engineer.
Layman, E. F........Civil Engineer............Cincinnati..Hamilton
32 E. Third St.
Lee, R. H............Civil Engineer and Surv'or. Harlemsprings, Carroll
Leete, Fred G........City Engineer.............Ironton.....Lawrence
Legg, E. E.........Civil Engineer............Columbus..Franklin
251 N. Garfield Ave.
Leonard, M. F.......County Surveyor and City..Gallipolis...Gallia
Engineer.
Lesher, Geo. W......Civil Engineer and Surv'or. Fremont....Sandusky
Lewis, Chas. F......Bridge Engineer..........Cleveland..Cuyahoga
307 Cuyahoga Bldg.
Lewis, C. McK. .....Bridge and Signal.........Cincinnati..Hamilton
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*Lewis, Harvey J....Civil Eng., general practice. Pittsburg, Pa.
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Lilly, G. W	Assistant Engineer Dept. of Public Improvements.	Columbus	Franklin
Lilly, J. A	Civil Eng. C. L. & N. R'y	Cincinnati	Hamilton
Linton, W. H	City Engineer	Ravenna	Portage
Locke, Jos. M	Civil Engineer	Cincinnati 40 E. Third St.	Hamilton
Long, M. A	Ass't Eng. B. & O. R'y	Cincinnati	Hamilton
*Loofburrough, E. C.	City Engineer	Lorain	Lorain
Loomis, A. B	Civil Engineer and Surv'or.	Toledo The Monticello.	Lucas
Lorce, W. C	Acting Superintendent P. C. C. & St. L. R'y Co.	Columbus Union Station.	Franklin
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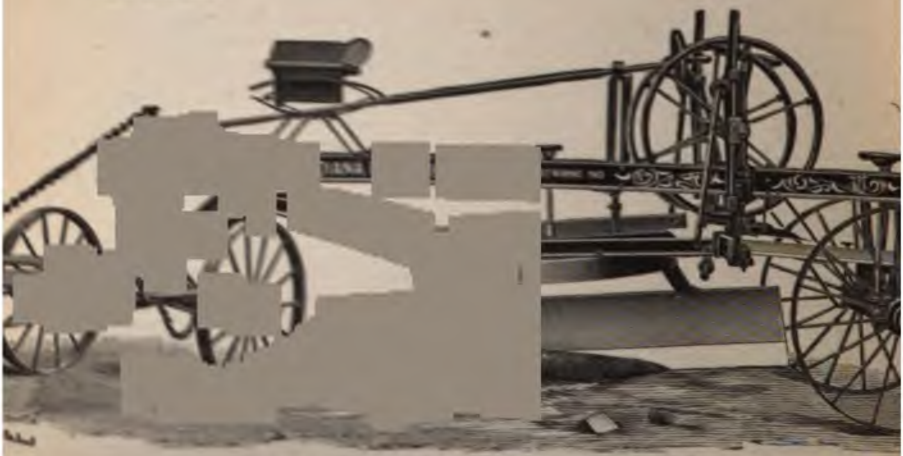

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...1901...

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PRESIDENT'S ADDRESS.

Fellow members:

The field of past achievements has been reviewed so thoroughly and ably by Ex-President Kemmler, in his annual address before this Society last year, that I shall not attempt to improve upon it, but instead will read you an original fairy tale, the scene of which is laid in the twentieth century.

Imagine a bright lad calmly and confidently guiding the swift pace of a huge automobile chariot. Upon his fair young brow intelligence sits enthroned. His matchless symmetry and grace impress the observer with the great possibilities in development. An aureole of electric glory surrounds him.

Thus do we behold the Prince of the twentieth century. Young in days and heir to the experience and achievements of past ages, never was the future of youth brighter than his.

The chariot driven by our fearless Prince deserves a passing notice. Drawn by invisible steeds, a dazzling array of levers, wheels, wires, dynamos, generators, compressors, alternators, transmitters, and commutators, bewilder the mind. Each part performs perfectly the work for which it was designed.

The seemingly conscious obedience to the controlling hand gives to the machine an attribute closely akin to human—the acme of the wonderful achievements of the past!

Notice the tender solicitude of the Prince for every part of his machine. The slightest irregularity is observed and immediately adjusted. Beneath his caressing touch, awkward parts become graceful, while working capacity and durability are increased. A greater degree of confidence is placed each in the other. The Prince does not hesitate to call upon his machine for wonderful exhibitions of power, and it bounds forward at the slightest expression of the will of its master.

"Here, give me your hand! Jump!" Here we are, safe behind the Prince, where we will be out of the way, and yet in an excellent position from which to make observations.

"Now, hold on!" for I perceive from a glance at the Prince's face that he is about to try the mettle of his spi

The Prince recognizes our presence with an approving smile only, and immediately turns away, giving his attention to other matters.

The action of every part of the machine is carefully observed, an intricate system of levers and wheels is rapidly manipulated, and results carefully noted.

We observe that the face of the Prince has assumed a more mature expression. No longer is he the expectant youth. Strong, sturdy, young manhood is indicated by every lineament of his countenance.

For the first time we observe that we are moving rapidly, so imperceptibly had the start been made and so uniformly had the speed been increased.

With a speed surpassing the swiftest train, familiar objects are passed in rapid succession. Anxiously we glance along the way, fearing some terrible catastrophe, but, fortunately, as far as eye can reach, no living being is in sight.

For the moment our fears are relieved. Every foot of the road before us is familiar ground. As we glide swiftly by, a well-remembered spot recalls an exciting dialogue with the county commissioners when we were macadamizing the road. Other points bring to our remembrance interesting conversations with property owners relative to grades, etc.

Suddenly a new fear possesses us. For five miles the road ahead of us is perfectly straight, when it suddenly terminates on the top of an abrupt bluff, overlooking a fertile valley two hundred feet below.

"Stop the car! Prince, stop!" we shout; but he heeds us not. We rise hastily to attract his attention, when we are confronted by a queer little man whom we had not noticed in the car before. His face was stern and forbidding, and, with a gesture, which we understood as a command that we should resume our seats, he occupied a position between us and the Prince, making it impossible for us to reach the Prince without his consent. We felt that our last hour on earth had come. The electric fluid, that supplied the motive power to the machine which was hurrying us to destruction, did not travel along the wires more rapidly than did the thoughts of the past deeds of our lives flash through our brains. We thought of all the unkind things we had ever said about the county commissioners, the city council, or our brother engineers.

Suddenly a mournful dirge is borne upon the air, sounding not unlike the first whisperings of the spirits of ten thousand tornadoes. The speed of our vehicle is increased many fold. The face of our Prince, inspired by confidence, shines brightly. We are upon the bluff. A mighty, deafening roar of protest ascends to heaven from the machine as it pauses an instant on the edge of the

bluff. A glance reveals a populous city, quietly reposing in the valley below.

Instinctively we close our eyes, and, with an unuttered prayer on our lips, we make a mental calculation of the number of seconds it will take to reach the valley. One—two—three—four—five—six! What! not dashed to pieces on the rocks below, but floating through the air. Oh, the joy, the ecstacy! The reaction was too great, too sudden. Had it not been for the queer little man, in our delirium of joy we would have leaped from the car to meet the fate we had just escaped.

Relieved of the fear of a horrible death, we are soon able to observe with calmness our surroundings. The deafening roar of the machinery has ceased. A subtle vibration indicates the enormous speed of revolving points of the mechanism. On either side, huge wings have been thrown out which give to the chariot the appearance of a monster bird, poising in mid-air. Familiar objects in the valley glide swiftly by. In the city beneath us are gathered groups of excited people, gazing skyward and gesticulating wildly. In our passage over the city we came close enough to the earth to recognize many acquaintances. In a secluded spot a prominent alderman was seen walking arm in arm with a well-known contractor. As we hovered over the line of a sewer under construction, teeming with a swarm of busy workmen, the inspector, in company with the contractor, emerged from a near-by saloon. The former, catching sight of us, became visibly agitated, and as he reels toward the street, we hear him exclaim, "O Lord, forgive me, and I 'll never do it again!" and, plunging headlong into the open trench, breaks his neck.

Slowly we pass from the spot, gradually leaving the city behind. The course of our ship is now directed southwesterly. We say "ship," for it must now be apparent to all that our automobile, chariot, car, vehicle, machine, or whatever my hearers may be pleased to call it, is an air-ship of the very highest grade known to ærial science, with many improvements thereon. The velocity of the ship was entirely under the control of the Prince. Slow or fast we went, as the will of the master-mind dictated. Now we descend within hailing distance of the earth, now we arise above the clouds. The ship is kept unerringly on its course. Fair cities are succeeded by broad landscapes. The capital city of the great State of Ohio is now beneath us. The capitol building is directly in line with our course. Our ship was supposed to be at an elevation of sufficient height to pass over the building, but such was not the case. When, too late to avoid it, it was noticed that the ship would strike the flag-mast upon the top of the building. This, however, being a temporary affair, and somewhat ancient, promptly snapped off close to the roof. The fragment, however, was caught and carried away by the ship. This little accident was noticed by

many members of the Assembly. The circumstance was universally regarded as an ill-omen. With blanched face, neighbor turned to neighbor, and received only a confirmation of his fears, and tradition says that for many days thereafter the rulers and law-makers of the land, in the sacred discharge of their obligations, departed not from the paths of rectitude.

Our ship sped on. Passing the home city of our esteemed Secretary on our right, we were soon hovering over the Queen City of the West. The fragment of the flag-mast, still clinging to the ship, became detached and fell, striking the earth in front of No. 1546, on Baymiller Street, just as the occupant, who proved to be a civil engineer, and an esteemed member of this Society, emerged therefrom. "An ærolite, by thunder!" ejaculated Mr. Harper, for he indeed it was. He picked up the fragment and carefully examined it. With a look of perplexity on his face, he said: "I never heard of a wooden ærolite, but I never saw anything like this on earth. I will accept it as a good omen, and will hang it over my door for good luck!" His biographer says that the latter part of Mr. Harper's life was crowded with engineering schemes for the enrichment of mankind, all of which were successfully carried out.

The city with its smoky evidence of prosperity is soon left behind. Our course now for many miles is along the beautiful valley of the Ohio. The scenery before us, to the lover of Nature, beautiful and enchanting, is beyond our power to describe. Gazing upon the scenery around us until our eyes became weary and our minds perplexed, we turned, half-conscious of the presence of a third party, to discover the queer little man, whom we had met before, standing near by.

Bowing low, he approached, and, raising his hand to his cap in true military style, he addressed us in good English, with a slight foreign accent not unpleasant to the ear. "The gentlemen will please follow me to the dining-room, where they will be served with refreshments." Following him, we found ourselves in a small room with a low ceiling. Although small, the architectural features of the room were grandly designed and executed, and the furniture, arranged to take advantage of the small amount of available room, was rich and costly in workmanship. We were invited to seat ourselves at a small table. The clear ring of an electric bell in an adjoining apartment was immediately answered by the entrance of a diminutive waiter, carrying a tray upon which was set an assortment of dishes containing odd-appearing mixtures. Placing the tray upon the table, the waiter withdrew, leaving us again alone with our guide. The repast was spread before us. Our guide, noticing that we did not partake of the food which he had prepared, said: "Gentlemen, feel free to eat what has been prepared for you. This ship is on a voyage which

will last several weeks. It will therefore be necessary for you to refresh the inner man frequently while you are its honored guests."

Thus encouraged, we felt it our duty, as a matter of courtesy to our host, to partake of the food before us. The result was a pleasant surprise. The various dishes were very palatable and appetizing. Each preparation possessed a distinct flavor of some fruit or vegetable or meat, and the flavor testified that the cooking was of the highest order.

Noticing our surprise, our host said: "The preparation of our food is entrusted only to professional cooks, who have completed with honor the course prescribed by our universities. In this course, special attention is given to dyspepsia and its causes and the prevention thereof. Consequently this much-dreaded disease and many kindred derangements of the stomach rarely require treatment by our physicians, the effect of which has been to materially increase the average length of life."

No longer did we hesitate to show our appreciation of the kindness of our host, who had the satisfaction of seeing the dishes before us rapidly emptied. The faint tinkle of an electric bell was immediately followed by the entrance of a waiter, who rapidly and noiselessly converted the dining room into a parlor. From hidden recesses were wheeled luxurious chairs, which we were invited to occupy. A constantly-moving and never-ending panoramic view of the country through which we were passing was visible on either side of us through richly-curtained windows of extreme transparency, extending from the floor to the ceiling. Rugged hills, skirting the valley, clothed in a coat of many colors, delight the eye. Now they tower above us, majestic and haughty in their grandeur, while their precipitous sides rudely encroach upon the boundaries of the silently-flowing river many feet below us. Now, retreating, distance lends grace and charm to the uneven contour, the rugged side, and the barren peak, while before us for many miles is stretched a beautiful undulating valley, teeming in fertile lands and populous cities.

The rapidly-changing scenes, the novelty of our position, and the unaccustomed height at which we were traveling above the earth, so wrought upon my sensibilities, that, forgetting all ideas of the proprieties, I cried: "Tell us about this wonderful machine upon which we are riding, this prodigy of human skill, endowed apparently with more than earthly power. How has it all been brought about?"

Turning at the sound of my voice, a smile spread over his face as he noted my bewildered countenance and the boyish eagerness with which I asked the questions. And this is the story he told:

"This ship is not the result of the investigations of one man, but it is the incorporation of the best ideas of mar From

the days of Daedalus, who, according to Grecian mythology, made use of artificial wings, men have coveted the power of the birds. While many early attempted solutions of the problem were made, usually ending in more or less disastrous failure, not until the latter part of the last century were the efforts of scientists rewarded with the promise of success. The nineteenth century, which was noted for marvelous advancement along all lines of scientific research, gave birth to many enthusiastic advocates of ærial navigation.

"Oliver Chanute, an American engineer, conducted a long series of experiments with gliding machines. From personal observation from his machine during its flight, he demonstrated the now well-known fact that the wind, flowing up a hillside, is not a steadily-flowing current like that of a river. It comes as a rolling mass, full of tumultuous whirls and eddies, like those issuing from a chimney, and they strike the apparatus with constantly varying force and direction, sometimes withdrawing support when most needed. (*McClure's Magazine*, June, 1900, 'Experiment in Flying.') The observations made by him regarding the effect of the wind upon ære-plane surfaces under varying conditions have led to a more extensive study of the subject, resulting in a vastly increased store of knowledge.

"Otto Lilienthal, a German scientist, conducted a series of experiments along similar lines. To him is due the demonstration of the superiority of concave wings over flat wings. In August, of the year 1896, while experimenting with one of his gliding machines, he fell and sustained injuries from which he died. He is credited with having been the first experimentor of modern times to accompany his machine in its flight through the air, and in his untimely death the cause of ærial navigation lost an able advocate. Until recently it was supposed that the store of knowledge which he had gained from his years of experience and observation was lost to science, as no record of his work could be found. A recent discovery, however, has brought to light a voluminous manuscript, which proves to be the work of Mr. Lilienthal, giving in minute detail the results of his observations, and adding greatly to our knowledge of the subject of ærostatics.

"The experiments of Prof. S. P. Langley, Secretary of the Smithsonian Institute, and Hiram S. Maxim, inventor of the Maxim gun, were steps in advance of the others, inasmuch as they did not depend upon muscular power, but employed mechanical power to move and sustain their machines in the air.

"Probably the most expensive experiments carried on during the nineteenth century were those conducted by Count Zeppelin. His machine consisted of a series of seventeen balloons, encased in a cylindrical shell divided into seventeen compartments. The shell was over four hundred feet long and thirty-eight feet in diameter.

Suspended beneath were two aluminum cars containing the machinery for propelling the ship, and the operators. When completed, the total cost was over $100,000. Upon the second day of July, in the last year of the last century, a trial trip was made, which proved to the inventor that he was on the right track.

"About the beginning of the present century, William Kress, an Austrian engineer, invented an air-ship which, in some respects, proved to be an improvement upon Zeppelin's. The Emperor became interested in the success of the enterprise, and contributed liberally for the prosecution of the work. The example of the Emperor was followed by other men; and, finally, by nations, to such an extent that new life and activity were infused in aerial navigation circles. Money flowed freely. The Aerial Transportation Syndicate was formed with a capital stock of one billion dollars. Inventors, with all the skill that science could supply, were set to work, and, without going into detail, much of which would be tedious, the ship upon which you are riding is the result of a long line of investigations and experiments made by inventors and scientists from every country and nation upon the face of the globe."

"This is wonderful! Amazing!" I exclaimed. A peculiar trembling of the ship attracted me. A glance through the window showed that we were no longer traveling at a high rate of speed; in fact, we appeared to be at a dead stop in mid-air, and were it not for the peculiar motion referred to, no sign of action could be seen about the ship. A look of inquiry at our guide elicited the following statement. Stepping to the window and pointing to objects in the distance, he said, "Do you notice the peculiar wavy appearance of objects seen through the air just beneath the aeroplane above us?"

"I do," I answered.

"The effect," said he, "is produced by an innumerable number of rapidly-moving and [illegible] attached to the underside of the aero-plane. Many years ago, Professor Pettigrew analyzed the action of [illegible]. The [illegible] of [illegible] investigations, coupled with [illegible] made by means of the [illegible] words, gave scientists the [illegible] the proper form [illegible] machinery necessary [illegible] motionless suspension [illegible] motion, and [illegible] plane convert[illegible] This part of the [illegible] desired to stop [illegible] on cargo, passengers, [illegible]

"Indeed," said I, [illegible]

"Follow me," said the guide.

In an adjoining room we beheld several diminutive workmen busily engaged piling boxes and packages upon a car, which, upon pressure of a button in the wall by one of the workmen, instantly disappeared through an opening in the bottom of the ship, and by means of ropes operated by machinery in a distant part of the ship, was lowered to the earth beneath. A hasty glance through the opening revealed a busy throng of workmen several hundred feet below us. Guy ropes from various parts of our ship had been dropped and fastened to anchors below. In an incredibly short time the car, reloaded, had returned, the signal was given, the guy ropes were cast off below and raised, and we were again on our journey.

"Wonderful! Wonderful!" I cried. "And the power—how do you propel the ship?"

"By electricity," he answered.

I presume my face showed my incredulity, for it seemed impossible that electricity could be used with economy as a motive power. He explained: "With the aid of the most economical methods known to the nineteenth century, it would be impossible to use electricity on an air-ship with economy; but, since the end of the last century, vast strides have been made in the study of the production of energy. The potential energy of coal is converted directly into electrical energy by a chemical process, the use of the steam engine for that purpose being no longer necessary. Formerly, about fifteen per cent. only of the potential energy of coal was delivered to the dynamo; by the new process as high as ninety-five per cent. has been obtained."

In answer to a signal, our guide hurriedly excused himself, stating that his presence was needed in another part of the ship.

Left to ourselves, the wonders of our surroundings assumed such prominence that all ideas of propriety were forgotten in the gratifying of curiosity. Everything about the ship was subjected to the most scrutinizing inspection. The wonders in mechanical design and construction of the ship proved to be as much a revelation to us as had been the manifestations of its power.

Wherever it was possible to lighten the weight of material without proportionately decreasing its strength, it had been done. Not a bracket nor fancy scroll was observed but what in some way helped to strengthen the ship or to add to its developing power.

In fancy, I gazed down the vista of years to come, which, dimly lighted by the early dawn of a rising sun, destined to shine upon an age of terrestrial development, in splendor and glory unequaled in the past, and with a keenness of vision, apparently adapted to the twilight, I saw that which no mortal man, regardful of the opinions of his neighbors concerning his sanity, would dare to utter.

And now, gentlemen, allow me to thank you for the honor which

you conferred upon me one year ago by electing me to fill the highest office in the gift of the Society—an honor accompanied by great responsibilities. The honor was appreciated; the gravity of the responsibilities, I am afraid, were not. Failure to realize the importance of the duties devolving upon the President, well-nigh ruined the success of this meeting, or at least made the load carried by the Secretary much harder to bear; and I feel it my duty to offer a few suggestions along this line that may be beneficial to others in the future.

Immediately after the dismissal of this meeting, while faces and events are still fresh in the mind of the newly-elected President, he should appoint his committees and advise each member of his appointment. Throughout the year, at intervals of about one month, he should keep up a correspondence with the chairmen of his committees. Early in the season, volunteer papers should be called for by a printed circular letter addressed to each member of the Society. Volunteer papers will be easier to obtain in this way than if the call is not made until later in the season. The program can then be arranged and printed in good time to be circulated among members before the time of the meeting.

If the work is promptly taken up by the President and carried successfully through to completion, he will have the everlasting gratitude of the Secretary, who can then devote his time to the preparation of the Annual Report.

Individual work of every member of the Society in securing advertisements will be appreciated by the Secretary. In every town in the State of five thousand inhabitants and upwards, one or more orders for advertising space might be secured if the local engineers will use their influence.

I desire to make a few suggestions affecting the future usefulness of this Society.

As the nineteenth century was a marked improvement upon the eighteenth century, and, in its turn the eighteenth century exceeded the seventeenth in practical results for the betterment of mankind, we are justified in reasoning from analogy, and from our knowledge of the present imperfect development of many commercial projects, that the twentieth century will witness the triumphant perfection of many unfinished projects of the nineteenth. If our Society is to continue its usefulness, it must be progressive. The Constitution and By-laws which answered for 1885 are, in some respects, out of date for 1901. I would suggest that it be the duty of the Trustees to recommend such amendments to the Constitution and By-laws as deemed advisable, and, if adopted by the Society, that the same be published in the next Annual Report under the head of Amendments to Constitution (or By-laws), and that every five years the Constitution

and By-laws as amended up to date be printed in full in the Annual Report.

This unique departure from the usual annual address of the President was much enjoyed, and greeted with a hearty outburst of applause upon conclusion.

The Chair: "The next paper on the program is 'A Review of the Engineering Progress During the Nineteenth Century,' by Prof. C. N. Brown, Chairman of the Committee on Civil Engineering."

"As Professor Brown does not seem to be present, we will hear the next paper, by J. B. Strawn, Salem, on 'Portland Cement and Some of Its Uses.'"

Mr. Strawn: "Not expecting to be called on at this time, and hoping to have the benefit of some of Professor Brown's remarks on the engineering work of the nineteenth century, I feel a little out of place just now."

The President of the Massachusetts Institute of Technology says that the coming man, or the man of the twentieth century, is to be the engineer, and President White has shown in his interesting address the great possibilities which lie before him, greater than the world has ever seen, and now the speaker believes the great medium in construction for the twentieth century is to be Portland cement concrete.

PORTLAND CEMENT AND SOME OF ITS USES.

By J. B Strawn.

Portland cement, as distinguished from natural cement in general use, is a cement which possesses the property of hardening or setting under water; is heavy, is slow setting, and has great ultimate strength. Strictly speaking, "Portland cement contains lime, silicia, alumina, and oxide of iron; these, in the process of burning, have become silicate of lime and alumina, and aluminate of lime and ferrite of lime. If these compounds are united in exactly the right proportions, their nature is such as to crystallize, when wet with water, and then harden till they become as rock."

The cement used by the Roman engineers in the palmy days of that once mighty empire, and the enduring properties it possessed, has marked an era in physical structures that was epoch making. The monumental works yet standing, and in a state of good preservation—structures built before the beginning of the Christian era—attest the value of cements manufactured at that far-off period. A brief reference to some of these most remarkable structures will be of interest at this time.

The Pantheon, built by Agrippa before the birth of Christ, a

temple dedicated to all the heathen deities, is now a church dedicated to the Virgin Mary and all the martyrs. It was a temple of circular form, and is called now the Rotunda, and is one of the finest edifices of modern Rome. The enormous dome of the Pantheon is 142′ 6″, and is cast in concrete. Being one solid mass, it covers the building like a great hemispherical shell, free from any lateral thrust at the haunches.

The walls of the Pantheon likewise are concrete, now faced with brick. The steps to the forum had concrete coves, which remain. Pedestal coves of concrete remain. The circular podium around the Temple of Vesta, about ten feet high, still exists. The great platform of Nero's palace and the pyramid of Cestus are other of the many remains of concrete in ancient Rome.

The concrete foundations of the house of Sallust, the Roman historian, who lived in the first century B. C., were found in excavating for other building extensions to the Via Nazionale in Rome, and it was necessary to blast them with dynamite.

Turning from these interesting monitors of the far-off past—monitors that endured for two thousand years, and have borne testimony, and, perchance, will continue for thousands of years hence to testify to the everlasting endurance of concrete. With the fall of Rome many of the arts and sciences of that day were lost, one of which was the manufacture and manipulation of cement.

Almost two thousand years pass, after the fall of Rome, and down to a period within the recollection of the present generation. Joseph Aspdin, a brick-layer of Leeds, England, after numerous experiments, made for the production of artificial stone, in 1824 procured a patent for the manufacture of what he named Portland cement, naming his cement-stone after the famous "Portland" building stone of England.

By general consent the credit of first manufacturing Portland cement is granted to England. Nominally, Joseph Aspdin, of Leeds, was the father of the industry.

It took twenty-five years for this cement to battle its way to the front, when, in 1850, John Grant, M. Inst., C. E., through numerous experiments, made for the London Drainage Works, established it as a material upon which engineers could rely to the fullest extent. England commenced the manufacture, soon after this, of Portland cement. Other countries of Europe soon followed—France in 1846, Germany in 1855. Germany is now the largest producer of Portland cement, in 1899 producing between 18,000,000 and 20,000,000 barrels. England stands second, producing about 8,000,000 barrels; France about 3,500,000 barrels annually.

Of Germany's 20,000,000 barrels, about four-fifths of the output is used by the German nation; the main bulk of the remainder, or 4,000,000 barrels, comes to the United States. The German cement

manufacturers early formed themselves into an organization, not as a *trust* exactly. Their efforts were to produce a good, reliable cement, and then to make this fact known to cement users. The confidence of American engineers in well-known brands of German cements requires no comment at this time.

The belief seemed general that there could be no cement produced in this country to take the place of the German and English Portlands. While this country was producing a high-grade natural cement, a cement well adapted to most requirements of the time, the manufacture of Portland cement in this country was delayed until early in the seventies, when David O. Sayler, of Coplay, Pa., a manufacturer of natural rock cement, turned his attention to the possibility of producing a Portland cement from this same natural rock. After numerous and patient experiments, he discovered the secret for which he had been seeking. The secret was simply to break down the natural rock into an impalpable powder, mix with water, mould into bricks, dry, and then calcine and grind these bricks. This practice is generally followed by cement manufacturers, both in the United States and in Europe. Quite recently there have been important improvements made in the handling of the material, after it has been prepared for the kiln. Now there are the two processes of mixing the material, which may be known as the "wet" and the "dry" process.

To grind the rock, marls, clays, or other materials entering into the mixture for producing a Portland cement—to mix these with water, mould into bricks or balls, or to mix the fine particles into a semi-fluid called *slurry,* which has to be run out on a drying-floor, after which, when dry, is broken up into pieces ready for the kiln—both of these methods followed in the "wet" process required great labor and large works for preparing and drying the *bricks,* or the *slurry* ready for the kilns. Some of the great cement factories in this country now employ a revolving kiln for burning the prepared material for Portland cement. This form of kiln, while it originated in England, is distinctively an American development, the most important of which has been brought about by the Atlas Portland Cement Company, where the prepared mixture, in a dry state, is introduced directly into the revolving kiln at the one end, and is delivered at the other end of the kiln perfectly calcined. These kilns are about sixty to seventy-five feet in length, by about six feet in diameter. The shell is of plate iron or steel, and lined with fire-brick, externally having the appearance o fa large steam boiler. The dry, fine particles of the water lime-rock are fed into the kiln at the upper end, which is elevated sufficiently to cause the material within the kiln to gravitate towards the lower end during the process of burning. The kiln is slowly rotated on rollers by means of a screw working in cogs upon the exterior of the iron shell. The burnt product, when

delivered from the kiln, is ready for grinding. This process of burning the dry mixture in revolving kilns, manifestly lessens the expense in the production of Portland cement, while at the same time it insures the most perfect calcination of the material.

The fuel used for this purpose may be natural gas, crude oil, or powdered coal, which is introduced at the lower end of the kiln. A constant and uniform flow of fuel is maintained by means of a regulated blast.

The grinding of the clinker to an impalpable powder for a second time completes the process of manufacture of Portland cement, as carried out in one of the most complete as well as, possibly, the largest cement plant in the world, the Atlas Portland Cement Works, at Coplay and Northampton, Pa., where 4,000,000 barrels of cement are produced annually, a quantity greater than the entire product of France, half as much as England's combined annual production, and about one-fourth as much as the seventy factories of Germany, and in quality is equal to the best.

The rapid growth of the Portland cement industry in the past few years in the United States would indicate that, at the close of this decade, the United States will be the leading country in the world in the production of Portland cement.

The manipulation of and some of the uses of Portland cement will claim our attention for a few moments, in which the writer will not be confined wholly to relating his own experience, but will draw upon the experience of some who have had a wider and more valuable experience than he has had. While it can safely be said that the production of Portland cement in the modern civilized world scarcely antedates the birth of some of the members of this Society, and its practical application in structural work was not recognized until after 1850, and, further, that it was not manufactured in the United States as a commercial product until after the centennial, 1876, since which the claims of Portland cement have steadily been gaining in popularity until now it bids fair to supersede both brick and stone for many purposes, wherein, ten years ago, no architect nor engineer would have risked his reputation on permitting its use. Owing to the plasticity of concrete, with its rapidly-gaining popularity for almost all kinds of masonry, it is certain to ultimately be adopted for much of the more expensive work where stone has been almost exclusively used. While a want of knowledge and experience in the use of Portland cement has resulted in failure, in some instances, and in other instances mercenary interests have been stronger than the desire to render faithful service, or, to do honest work, with these drawbacks, and many others, "it has come to stay." Reliable firms are now contracting on the large scale for a variety of construction in structural and ornamental work in Portland cement concrete.

In concrete work, as in most work of construction, much depends

upon suitable materials, and a proper understanding of how to use these materials: First, a good and reliable Portland cement is required; second, a good quality of sand, preferably clean, sharp sand; third, hard, clean crushed stone, clean, hard gravel, or these combined. The character of the work in hand will determine the proportions of cement and sand and the crushed stone or gravel.

The quality of the completed work will depend, first, on the quality of the materials used and a proper combination of the material, and then on thorough mixing and in the handling and placing of the material in the work, form, or mold.

The writer believes it is unwise to change off from one brand of cement to another. Ordinarily, these makes of cement, while they may all be good, must be tried. You must become acquainted with each. Few cements are alike in use or in action. First, select a well-known reliable make, one that has been thoroughly tested by well-known engineers. The wider range these tests have the better; then, the better plan would be to stick to that brand, mainly for the reason that, from the nature of nine-tenths of the work done in concrete, it is impracticable to test the cement beforehand, and a strange cement is like an unknown mechanic—you want to try him before giving him a permanent job.

The writer had an interesting experience, quite recently, on the construction of a storage reservoir, where a considerable quantity of Portland cement was required, the contractor furnishing the material. The cement was one of our high-grade American Portlands. It happened that the quantity of cement required was much more than the contractor had furnished. His foreman was notified of the necessity of having cement ready to complete the work. It was promptly furnished and delivered on the grounds; but it was not Portland cement. It was a very cheap, natural cement, shipped in Portland cement sacks. Careful examination of these sacks established their identity. They were the sacks which had contained part of the Portland cement already used, the foreman having gathered up the empty sacks and shipped them to the contractor, where they had been filled with the common cement. "For ways that are dark and tricks that are vain," this water-works contractor was peculiar. The contractor was notified of somebody's mistake, and he furnished the genuine article, when the work was resumed.

SAND AND GRAVEL.

It is stating it mildly to say that not enough attention is paid in the selection of sand and gravel for concrete work. More failures in concrete result from poor sand and gravel than from poor Portland cement. The past five years the writer has used a large open platform on which to mix concrete, the mixing being done by hand. Where gravel was used for the aggregate which contained sand in sufficient volume, when packed, to fill the voids, the aggre-

gate has been thoroughly wet, drenched with water, and stirred, to wash out the loam, after which the cement was evenly, or, as evenly as a workman could spread it from the open mouth of the sack; then the rake was applied for leveling and evening up the cement distributed over the gravel, which is about four inches deep. About three or four turnings were sufficient. By a little watching and study of the material, there need be no mistake in the temper of the concrete. The writer prefers a moderately wet concrete, one that quakes under the rammer, but not sloppy. Ordinarily the voids are more perfectly filled when the concrete is moderately wet. A good concrete may be made by the dry mix, which is very popular with engineers, especially on government work. Work may be pushed along a little more rapidly in using the "dry mix" than with the "wet." However, the difference between the two mixtures ordinarily is but slight, and both, properly handled, give good results. Laboratory tests of the strength of wet and dry mixtures show that, on short times, the dry mixture shows a somewhat greater strength than the wet, but that in time the wet becomes as strong as the dry. Ordinarily, concrete should be deposited in layers of about six inches in thickness, and thoroughly compacted by tamping. Where it becomes necessary to place concrete upon concrete laid the day before, or upon old work, care must be used to, if possible, avoid cracks, which, ordinarily, may be done by carefully scraping the top of the old work, then thoroughly wet or saturate the top of the old work with water; when about dry give a coat of cement, grout, or wash.

Cement sidewalks have been extensively constructed in the larger cities for the past ten years, and for the last few years have almost entirely superseded brick and flag-stone. The cement walk is superior in all respects to any walk, and costs about twenty-five per cent. less than two-inch flag-stone. It is next to impossible to lay a stone walk that will not, in a short time, become uneven, whereas the cement walk remains just where it is placed. Further, it is the safest walk, both summer and winter. There are no ups and downs to cause stumbling, falling, and profanity in summer, while in winter it is freer from ice than any other permanent walk.

Cement concrete is being used successfully for carriage drives and for heaviest traffic, for street curbs and gutters combined, making the handsomest, cleanest, and most economical curb and gutter for improved streets yet devised, and will stand harder usage and last longer than the standard sand-stone curb, and will remain true in place without staggering, like the stone curb.

Foundations of cement concrete are now regarded as a necessity for almost all large, permanent buildings, as well as for bridge work, retaining walls, and for most all heavy masonry work.

The practical farmer finds many uses for cement concrete. He makes feed troughs for his horses, his cattle, sheep, and hogs, of

cement concrete. He puts new bottoms in his old wooden troughs of cement, paves his stable floors, carriage house floor, cellar floor, milk house floor, his poultry house floor, makes forms of plank, and fills them with concrete, and points you to the beautiful *stone* steps. The sills of his barn, especially where his stable door is located, is decayed. He removes the decayed part, boxes the opening, fills it with concrete, and he has a stone sill for the balance of his life. The sink at the pump has given out. He makes a box with beveled sides, turns it with bottom side up, places a box with vertical sides and four inches larger each way and two and one-half inches higher than his inverted box, fills it with concrete, and he has a sink for all time. The iron sink in the kitchen has rusted through. He places a piece of iron or tin over the opening, and puts a new bottom in his sink. The wife is happy and he is five dollars better off than with another sink to rust out. He even put a bottom in a large wooden sink, and it is all right. These little conveniences and comforts could be multiplied.

While the foregoing uses of concrete are among the more common and ordinary, the crowning triumph in Portland cement concrete is to be seen in the beautiful structures whose walls, both exterior and interior, are composed exclusively of concrete. One of these speciments will be found in St. James Church, Brooklyn, New York. The building in plan is cruciform, and is one hundred and thirty-nine feet by eighty feet, with a massive tower eighty feet high, the four gables each being sixty feet high. "The building committee authorized the architect to adopt a unique material and method of construction. Instead of brick and stone, the material for the walls consists of granite concrete, combined with twisted iron or steel rods and prepared according to patent of Ernest L. Ransome. This method consists of building hollow walls of concrete, through the partitions of which are run, at proper points, rods of cold twisted iron, both horizontally and vertically, forming a fire-proof wall. The exterior walls are jointed, and while the concrete was in a tender state It was gone over with stone-dressers' tools to give the wall the appearance of genuine stone. "Too much cannot be said in regard to the general appearance of the work; it is cement work at its best."—From "Cement" for November, 1900.

Another fine building in cement concrete, and bearing the name of "Litholite Stone," has recently been completed at Harvey, Ill., for W. B. Thompson. "Litholite Stone" was developed and patented by C. W. Stephens, of Harvey, Ill. Litholite is moulded in any form desired, either for walls or structural ornamentation. The patentee claims for it economy, durability, and the texture of natural building stone.

It would consume too much time to attempt a detailed description of any of the many beautiful and artistic structures con-

structed of cement concrete. For a residence of graceful outline and rare beauty, that of F. Fiedeman, St. George, Staten Island, N. Y., may be mentioned as possessing charming details in design, and shows the possibilities of production in cement concrete.

Nowhere in this country has concrete shown to better effect than in the construction of bridges. Whether spanning the babbling, laughing brook, or the roaring, dashing torrent, or the spanning of our greatest rivers by successive arch and pier, the same lines of grace, beauty, and harmony are capable of expression in this most ready and responsive factor.

In 1898 the Pennsylvania Railroad Company built its first Portland cement concrete bridge or culvert. This culvert is located on the Erie & Pittsburg Railroad, about one mile from Sharpsville, Pa. The entire structure is of concrete. The span of the arch is thirty feet, being a true half circle. The bench-walls are about ten feet high. Length of arch about seventy-five feet. The work was begun late in the season, and, added to this, was an unfortunate brand or quality of cement first used, proving defective. The concrete had to be taken out and other substituted. The work was completed about Christmas. Notwithstanding the freezing weather, the work was carried on to a successful completion. The writer took several photographs of the work during construction. The walls were left just as they were moulded in the forms, the saw-curfs giving the face of the concrete quite the appearance of droved work on stone. The work shows well, and appears to be well constructed.

The Chicago, Milwaukee & St. Paul Railway has used concrete quite largely in its bridge work. W. R. Rogers, engineer of permanent construction, Bridge and Building Department, has written a valuable paper for the *Railroad Gazette*, Nos. 24, 27, and 30, on "Railroad Concrete Masonry." This is one of the most valuable papers on concrete the writer has read. A series of tests on a large scale, and covering several years, is being carried on by Mr. Rogers, for which the cement engineer will be richly paid for carefully perusing when completed, as well as of the article above referred to.

This is to be the new era in cement. The Cement Age is at hand, the dawn of a new era. "The day of ignorance regarding the true value of cement and its proper manipulation and application is fast passing,"* and all doubts and fears will be quickly dispelled, and soon will come the full realization, by those connected with the building art, that the stone of nature has at last met a successful rival.

Mr. Strawn interrupted the reading of his paper, after enumerating conditions necessary to success in the handling of Portland cement concrete, as follows:

Mr. Strawn: "I want to say that I had the pleasure of accompanying Mr. Griggs to the Hoster Brewery to see how they mix concrete and deposit it after patents of R——. They have the R—— mixer, and if any want to know how it should be mixed and deposited, you cannot do better than to spend a little time over there—*just to see the mixer.*" [Applause.]

Mr. Strawn then completed the reading of his paper, which was received with applause.

The Chair: "We will allow a short time for discussion of this paper."

Mr. Wilson: "I would like to ask Mr. Strawn a question. He speaks of Atlas cement, and I would like to know what per cent. it contains of silica or lime."

Mr. Strawn: "It seems to be about the same as the best brands of German cement. I do not remember the proportions. Sometimes they vary slightly, as the iron, alumina, and oxide of iron cause variations. The best test we have is in the actual use of the cement. When we find a thoroughly good cement, and one which has been tested by reliable engineers, we can afford to stand by that cement."

Professor Brown: "I can possibly add a little information regarding the first culvert on the Pennsylvania Lines. Mr. Strawn speaks of the cement that failed. I happen to know that that cement was natural and not Portland. The company wanted to economize in the cost of the structure, and the railroad engineers, against the recommendation of the consulting engineer in charge, insisted on putting in natural cement for a foundation. After being there for two or three days, it was shoveled out like loose stone. They then used Portland cement."

J. C. Cronley, Lima: "I believe the usual formula of silica and lime is about one-third silica and three times as much lime, or 22 and 66. I don't know that that cuts much figure in cement. Some time ago they had a big discussion in the East as to the amount of magnesia which could be in cement and not destroy its good qualities. Some allowed one per cent., some two, and some three. I don't know that any one ever specifies the different proportions of the ingredients of cement. As Brother Strawn said, we are more and more trusting to the knowledge and honesty of the manufacturers. When we get hold of a certain brand of Portland cement that we have faith in, we do not have a chemist analyze it and see if there are certain proportions of the ingredients in it, though I think it might be well to do it. For instance, the Buckeye Portland cement, I think, is as good as any in the world, yet there might be some carload of that cement which might not be up to standard. So I believe in giving all of it tests. The usual test seems to be that of tensile strength. I never heard anything said about its adhesive qualities. I don't know whether that has any-

thing to do with it or not. The English place stress upon that."

"Do you place any stress upon its adhesive quality, or rely altogether upon the tensile qualities?"

"As to cement walks, in our city they have been a complete failure, and have been taken up and replaced by stone, although I presume it is because the workmanship is bad. Two things are necessary—skill in handling and proper materials. In our place it has been a complete failure. In winter the walks are so slippery you can hardly get along; and after a while they crack and wear off on top, and the only thing remaining is the concrete under it. If they can be made durable, they would be the best that could be used. In our place the price is the same as for Berea sand-stone from Cleveland. Berea is two and a half cents a square foot, and the charge is the same for cement."

Mr. Strawn: "I will say that I have been so situated that I have built quite a good many walks. The walks are built of Buckeye building cement. I have laid six or seven hundred feet around my place, all in perfect condition to-day; also, the square on which the high school is built. I laid several thousand feet around that, and every block is in perfect condition. I guarantee that all work will stand for ten years. My own carriage drive is made of this material, where I have all my coal hauled over it. It was laid in December, and, with the exception of where is froze and rose up before it got hard, it is in good condition. It is tougher than any sandstone, harder than any sand-stone, and it needs is the necessary intelligence and care in manipulation of a good cement, good sand, and crushed stone. In my stable, where the horses go over it every day, is a cement floor, and it hardly shows the marks of the hardest calks, whereas stone is eaten down very soon. It is not for the horses to stand on, but in the entry, where they go over it every day."

Mr. Cronley: "It is hard for horses to stand on. How do you tell Louisville from Portland cement—by sight?"

Mr. Strawn: "By the color and weight. Anybody should have no trouble in determining Portland in the dark."

Mr. Cronley: "I could not tell it in the dark, but can tell it by sight."

A Member: "Give us the foundation."

Mr. Strawn: "I don't like the specifications in some cities. In Youngstown Portland cement sidewalks have been used for many years, and Engineer Lilley has made tests of cement of different brands, and has drawn specifications for the building of these walks. The excavation is made eight inches below grade line of the completed walk, fill four inches with mill ashes, well tamped, three inches of concrete on top, and one inch of richer mixture for wearing surface. He only uses four inches mill ashes below the cement. I generally use twice that, going twelve inches below the surface,

and in several thousand feet of sidewalks which I have put down there is not a single block which is not in perfect condition to-day."

Mr. Kemmler: "What proportions do you use in the top?"

Mr. Strawn: "Two of good sharp sand and one of cement."

Mr. Kemmler: "Do you use field gravel?"

Mr. Strawn: "Use clean gravel for the balance. I built a foundation for the standpipe at Napoleon, which was 125 feet high, the foundation being twenty-five feet in diameter, and it was necessary to raise the foundation a foot high. I used Buckeye Portland cement with crushed lime-stone. We had an exceptional quality of river sand, and the lime-stone was sent from the quarry with the fine particles in it. Contrary to the accepted rule, I mixed it right in—I wanted to restore it back to lime-stone—and I used a small per cent. of sand, and you could take a twelve-pound sledge and strike that foundation as hard as you wanted to. and you have the same rebounding as if you strike on rock."

Mr. Peters: "I have had a little experience with cement. I see there are some young men here, and I wish to say a word of warning to the young engineer just beginning the use of cement and concrete in place of stone. It is well to remember that God made the stone and man makes the cement and concrete. I have seen so many failures that, while I believe that everything claimed in this paper is possible, yet I think a great deal of it is not probable. I believe it is all possible. Of course those old buildings stand for monuments to cement, but remember that Longfellow, in 'The Builders,' said:

"In early days of art,
Builders wrought with greatest care
Both seen and unseen parts,
For gods see everywhere."

"I think our gods don't see everywhere any more, especially on public works. [Laughter.] I think if I were working for a reliable railroad company, I would rather use cement and expect to have success with it than if I were using it in public or municipal work. As far as the use of it in sidewalks is concerned, I have seen (and I have looked many places) about two failures at least to one success. In our city, about Heidelberg College, an ex-banker took it upon himself to put all the walks down with cement concrete, and it was to be an exhibition of skill and cement work. I presume it is about as good as could be done. It has been down about four years, and there are a number of faulty places showing. The fault may be in the workmanship. I believe it is possible to make it successfully, but we cannot see it all."

Mr. Wilson: "I hardly agree with Mr. Strawn with reference to sticking to one brand. If we all stick to one brand we will create a monopoly, a trust. I believe it is almost necessary, in fact,

it is necessary, to change around. Therefore, if we compare the mixtures of the different cements with those we know have stood the test, we can use them in certain classes of work. That was my object in asking the question regarding proportions. I will say that I have not been a friend to cement walks. Of course, in looking after the city work of Niles, and being interested in city work, I feel that a person cannot always get contractors who are honest, and you cannot always watch them. It is impossible. And, in putting in cement walks for individuals, the contractor wants to make as much money out of it as he can, and the consequence is, you have a poor walk. In Youngstown, my former home, we have a contractor in cement walks who is doing a large business; not only that, but I believe he is about as honest as you can make them. He put down a walk on the viaduct there, on the south side, and got it down a little bit late. He did everything he could to put in a good job, but the next spring the good Portland concrete was all blistered up so that, in some places, the concrete shows below. That shows how hard it is to get a good job. We know, as city engineers, that contracts must be let to the lowest bidder, if he is a responsible bidder. The question of 'responsible bidder' is a hard one to determine. A man may slight his work, but unless we have actual proof that he has done it before, we have to let it to him, because he is the lowest 'responsible bidder.' So that is my main reason for not being in favor of cement walks."

Mr. Sarver: "Cement walks can be put down to last, but they cannot be put down at the price of flag-stone work. Wherever we have laid cement at the same price as flag-stone, in every case it has been a complete failure."

Mr. Strawn: "It is want of knowledge of the material."

The Chair: "Possibly we had better pass to the next paper. As Professor Brown is with us, we will listen to his report, 'A Review of the Engineering Progress During the Nineteenth Century.'"

Professor Brown: "Mr. President, I am chairman of the Engineering Committee, and have understood that it was the duty of that chairman to secure papers from the members of the committee, and I was fortunate enough to induce Mr. Strawn to prepare one. It has also been the duty of the chairman of that committee to read a report of progress in engineering during the past year, and I thought it would be a good idea this time, as we stand upon the threshold of a new century, to take a glance at the progress during the past century and not confine myself to the past year. With that idea in mind, I have prepared the following paper":

A REVIEW OF ENGINEERING PROGRESS DURING THE NINETEENTH CENTURY.

By Prof. C. N. Brown.

The century that has just closed has been reviewed and described from many sides, and its praises have been sung by many pens far more facile than mine. I wish to call your attention for a few moments to the condition of engineering at the beginning and at the end of this record-breaking century.

In some lines we may well be surprised at the little improvement while in many other lines the progress has been by leaps and bounds, and has far surpassed the wildest dreams.

In the contemplation of our achievements we are prone to become filled with undue pride and self-esteem. A proper pride in work well done, or of obstacles bravely overcome, or of great inventions and discoveries contributing to the welfare of mankind, is all right and proper, but we must remember that we have had opportunities such as have never been presented to previous centuries; and we must consider whether or not we have made the best of these opportunities. We must remember that greater opportunities bring with them greater obligations and responsibilities; and we must strive to meet these and make the most of them, and not fold our hands and think that we have done well enough when we have done as well or a little better than our predecessors.

Let us glance into the past centuries and see as well as we may what has been done along engineering lines.

The first great difference between the engineering works of the centuries preceding the nineteenth, and of the nineteenth, is the extensive use of iron in these later days.

While the ancients, back to the time of early Egypt and Babylon, and other centers of ancient civilization, had iron, and possibly steel, they had it only as small pieces of wrought metal. It was used to a limited extent for arms and armor, tools, furniture, and ornaments. It was not until the fifteenth or the sixteenth century that cast-iron was formed into masses of any size for machinery, etc., and only since the later half of the eighteenth century that both cast and wrought iron have been manufactured in such form and quantities as to have any very great effect upon engineering construction. The nineteenth century has seen the establishment of, first, an iron age, and then a steel age, which begins the twentieth century with what seems to us fully-developed strength and vigor.

Without iron or any other metal, of proper qualities and sufficient quantity to replace it, the engineering works previous to the

eighteenth century necessarily fall into those classes of works that can be executed with little or none of those metals.

This will include many works of masonry, earth, and timber, such as roads, canals, bridges, and buildings of stone, brick, and timber. For such works all the metal required is that of the necessary hand tools for working the stone and timber. This they had many centuries ago, as is proved by the exquisite sculptures and buildings of Egypt, India, Persia, Greece, and Rome.

The timber structures have not, of course, remained, but we have descriptions of a few notable timber bridges, and it is remarkable how well many of the earthen and masonry works have resisted the ravages of time.

Let us now consider a few classes of engineering works in detail, and see what the progress has been.

ROADS.

While we have no record as to whether or not roads were among the first engineering works to be constructed by the ancients, we do know that several of the most ancient nations of historic times were notable road-builders.

No attempt will be made to go farther back than the Romans, because of all the ancient nations, they were the greatest road-builders. It was their policy to extend their great highways throughout all the empire, for the purpose of affording open ways for their armies and also for commerce and travel. Their road system covered all Italy, France, Spain, and Portugal, much of Germany and Austria, England and Scotland, and large areas in Asia and Africa. Parts of the roads they constructed fully two thousand years ago were still in use a few years ago. True, these roads were never subjected to a traffic such as is found on a busy street of a large modern city, but they have carried the loads that came to them, and have done so with little repair.

The Roman roads had a stone block pavement laid on a good foundation, usually of concrete or rubble masonry, but, being good engineers, they varied the foundation to suit the conditions, and we find references to piles and timber platforms. The road was narrow, had curb-stones, mile-stones, etc., and was usually very straight. They did not pay much attention to the grades, on account of the great attention given to directness.

Our modern block pavements differ in several ways from the Roman roads, but the concrete foundation is a return to their methods.

With the downfall of the Roman empire, road-building stopped for nearly eighteen centuries. At the beginning of the nineteenth century there were very few roads worthy the name in all the civilized world except the remains of those built by Rome.

There was an awakening to the value of good roads and to the

methods of building them about the same time in France and England, the leading nations of the world.

About 1775, Tresaguet, the inspector-general of bridges and roads for France, put forth directions for building a road of small stones much like what we call a Telford road. His methods were successfully used by the French in the construction of several important roads.

In 1816 MacAdam first put into practice his theories of road-building, which he had published in 1811. Telford built his first roads about 1816. There has been much rivalry between the friends of MacAdam and Telford as to whom belongs the credit for the idea of a road surface of small broken stone.

It seems to me that both of them must have known what was being done in France, and that both of them were following Tresaguet's ideas, and that to the Frenchman belongs the credit of introducing the broken-stone road in the latter part of the eighteenth century.

It is doubtful if we have made any noteworthy improvement in broken-stone roads during the century, the most important one being, probably, in the matter of rolling, but we still build many miles that have to be compacted by the traffic.

The modern stone-block pavement was introduced in Holland and Belgium about the first of this century. Improvements and modifications have been made leading up to the present practice, which, as has been said, resembles, in many ways, the best Roman roads built two thousand years ago.

The asphalt pavement is a product of the nineteenth century and the French Revolutions, and was introduced in Paris about 1838. Its great development has been made in the last third of the century, and is a great improvement on anything of the past.

The wood-block pavements are also nineteenth century productions, and were first introduced in London, England, about the year 1839. The use of wood in the shape of a corduroy road is not worthy of mention, and the plank roads were only temporary expedients.

The brick pavement is usually considered as a nineteenth century roadway, but it was used in the Netherlands in the thirteenth century, and some writers claim that it dates much farther back.

The American use of brick was probably independent of the Dutch practice, and began at Charleston, W. Va., in 1872.

Summing them up, we find that the nineteenth century has introduced the asphalt and wood-block pavements. It has reintroduced and improved the stone-block and brick, and has widely adopted the broken-stone roads which were given it at its birth.

CANALS.

Canals are used for several purposes; namely, irrigation, drainage, power, city water supply, as a highway, or a combination of these.

Previous to the nineteenth century we have records of canals used for all these purposes, except power, and some of these were of great magnitude and compare favorably with works of the present day.

The ancients of Egypt, Syria, and India, built many large canals for irrigation, and used them for highways. The Chinese have been great builders of canals for many centuries.

The canal lock used on the canals for highways was first introduced in the fourteenth century in Europe. We have enlarged and improved certain features, but it is still in general use for overcoming differences of level.

The first highway canal, as we know it, was built in France in the middle of the seventeenth century. It was 148 miles long, passed over a summit of 600 feet, had over 100 locks, and 50 aqueducts. England began canal-building about the middle of the eighteenth century, and covered the country with a network by the middle of the nineteenth century.

The first highway canal in the United States was opened in the year 1800. It was twenty-two miles long, with a number of locks and other structures, and was situated in North Carolina. The Erie Canal was not opened until 1825.

The end of the nineteenth century finds the small highway canal looked upon as a relic of the past, and a thing not to be further extended; but the large canal, or, as usually known, the ship-canal, is in high favor, and many have been recently built, and others are proposed for construction.

The most noted ship-canals are:

1. The Suez, opened 1870, 88 miles long.
2. The Amsterdam, opened 1876, 16½ miles long.
3. The Manchester, opened 1893, 35½ miles long.
4. The Cornith, opened 1894, 4 miles long.
5. The Baltic, opened 1895, 61½ miles long.
6. The Chicago Drainage, opened January 5, 1900, 26 miles long.

Some of the proposed are: The Panama, the Florida, the Nicaraguan, the Cape Cod.

Several of these are old schemes, and had been attempted or discussed long ago. The Suez canal closely follows the line of an old canal that was bult 600 B. C., and was in use about 1,400 years. The Cornith canal follows the line of a canal that was begun by Nero, but never finished.

When the Spaniards discovered the Pacific ocean, they discussed the building of a canal near the present unfinished Panama canal.

It is more than probable that the new century will see the completion of several of the schemes now proposed.

BRIDGES.

In bridges, the nineteenth century can boast of her metal structures, but n masonry bridges and timber she has to yield to foregoing centuries. It is probable that the earliest bridges were simple wooden beams or trestle bridges, but we have no records of them.

The earliest bridges of which any record exists are two stone bridges, one built by Egyptians across the Nile, of which we have no details, and a stone bridge at Babylon. From the meager descriptions we have of this bridge, it seems that the piers were about twelve feet apart, and the opening spanned by stone beams. It was in fact a stone trestle.

It is doubtful if the arch, as we know it, was used to any extent until the Roman engineers began building. They used the semicircular arch very extensively in their bridges and aqueducts, building in both stone and brick and spanning openings of nearly one hundred feet. The first stone bridge at Rome was built in the second century B. C.

The largest stone arch of which any record exists was built in northern Italy in the latter half of the fourteenth century, and was destroyed during a little war early in the fifteenth century. It had a clear span of 251 feet, and was a segmental arch.

The next largest stone arch is the Cabin John Arch at Washington, D. C., with a span of 220 feet, and finished during the Civil War.

The next is Grosvener Bridge, in England, with a span of 200 feet, and finished in 1833.

In timber bridges we have scanty records of ancient structures. The first bridge at Rome was a timber pile bridge, and was built in the second or third century B. C. Cæsar's pile bridge over the Rhine is one that many of us have read about. Trajan's bridge across the Danube, built early in the second century, is described as having timber arches of 170 feet span, but this is questioned.

The first bridge at London was of timber, built about the tenth century, but no description remains.

In the latter half of the eighteenth century three very remarkable timber bridges were built in Switzerland; one had a span of 390 feet, and the others 193 and 172 feet respectively. This span of 390 feet has never been exceeded in timber.

The early engineers of the United States built many timber bridges of good span during the early part of the nineteenth century.

The metal bridges may be said to have been devised and brought to a high state of perfection during the nineteenth century. The earliest form of the metal bridge was the suspension bridge, and a few small structures of this class were built during the latter half of the eighteenth century.

It is probable that suspension bridges with cables of rope were known and used in a small way long before the metal suspension bridge was introduced.

Closely following the metal suspension bridge came the cast-iron arch, in the latter part of the eighteenth century. The first cast-iron arch was built at Coal-Brook-Dale, England, with a span of 100 feet, in 1777. and was, a very few years ago, still at work.

In the early part of the nineteenth century many cast-iron arches were built, but at present cast-iron is not at all used in bridge-building.

The truss bridge of to-day is a production of the last half of the nineteenth century, and it is very pleasing to us to know that American engineers have been all the while in the lead in the development of this bridge. The first book giving explicit directions for finding the stresses in truss bridge members was published by Mr. Squire Whipple, whose name is given to one type of the truss bridge.

The metal arch has been developed more extensively in Europe than in America, but we have built some of the most noted examples of the arch.

DAMS.

Dams of great magnitude of both earth and masonry antedate the nineteenth century by hundreds of years. These dams were built to store water for irrigation, and had connected with them extensive systems of canals.

The reservoir dams of earth in India, built many centuries ago, have never been exceeded. Many of them have been repaired and again put in use by the English.

The Moors began the building of large masonry dams in Spain, and during the period of Spain's greatest prosperity and influence many more were constructed by the Spanish. A number of these dams are over one hundred feet high, and have stood for centuries. The French have followed the Spanish as builders of large masonry dams, and have brought the theory of their design to great perfection.

Some of the recent masonry dams exceed the ancient ones in height, and are better designed than the Moorish and Spanish dams, but follow practically the same lines as the early French dams.

BUILDINGS.

During the last quarter of the nineteenth century the character of large buildings has been much changed by the extensive use of iron and steel in their construction. But in masonry structures, both of stone and brick, the architect draws his models from the past, both for magnitude and artistic merit. It is impossible to enumerate all the examples we look back to; it is sufficient to mention the temples and palaces of India and Egypt, and Greece and Rome, the Gothic cathedrals, and the castles and palaces of Europe. These are to-day used as models for us to copy in proportion, decoration, and construction.

Probably in comfort and convenience we can show much improvement, especially in our housing of the masses of the people.

In heating and ventilating, lighting and sanitary matters we can show considerable improvement, although the Romans had their baths and water supplies and water-closets that are not far inferior to ours. The Romans and other ancient cities had public baths far ahead of anything now in existence.

WATER SUPPLY.

The great ancient cities had water supplies that command the admiration and respect of the present. The aqueducts and covered reservoirs of the past are not exceeded by any now in use. Rome in her prime had no less than twenty aqueducts, the longest being sixty-two miles long. Many of these were carried through tunnels and over long high masonry aqueducts. They well understood the value of abundant pure water to the welfare of their cities.

True, they did not have the general distribution to private houses that we enjoy, but their numerous public fountains answered very well. But in Pompeii have been found quite extensive systems of lead distribution pipes, with valves and faucets and stop-cocks of lead and bronze much like those now in use. These are beautifully illustrated in Herschel's book on the "Water Supply of Ancient Rome."

The purification of impure water has been developed in the last half of the nineteenth century, and we have many things about the distribution of water that the ancients did not know. We now often lift our supply from a low-lying river or lake, which they could not do for lack of proper machinery. Their supplies were all by gravity, which is still considered to be the best.

SANITARY PROVISIONS.

In this field the last half of the nineteenth century can show more progress than all the past centuries.

Many of the great ancient cities were sewered to some extent; but nothing has been found to indicate that any of them had the

complete system of hundreds of modern cities. In Pompeii and other ancient cities, water-closets very like good modern patterns have been found in perfect preservation. Neither is there any indication of sewage purification, as we understand the term. There was not the necessity of general purification of sewage in those days that now exists, on account of the comparatively sparse population.

A few of the old Roman sewers, built of brick, are still in use. The rather intricate system of drains and sewers about the temple in Jerusalem have been traced and studied. It is probable that the sewage from the temple was gathered in masonry tanks for sedimentation, and the effluent used for irrigation, and the settled sludge used as a fertilizer.

Frequent reference has been made to the advanced position of Rome and other ancient cities in matters of water supply and sanitation, as well as in other lines of civilization. When the Roman empire was destroyed by the invasion of the hordes of northern barbarians, most of these works were destroyed and their use abandoned by these people who did not understand or feel the need of them. Then, too, during the Dark and Middle ages, when ignorance and superstition and the church ruled supreme, the works and practices of the ancients were destroyed and abandoned because, inasmuch as these ancients were either Jews or heathen, therefore these things must be derived from the devil.

The ancients had believed in bathing and cleanliness, therefore the Christians must go dirty. The ancients brought pure water to their cities, therefore the Christians must use wells dug in the filth-laden soil within the city walls. It is stated that, for a thousand years, not a man, woman, or child in all Europe voluntarily took a bath. I suppose some of them would occasionally get caught out in a rain or fall in the creek.

It is no wonder that Europe was visited with such dreadful plagues and epidemics during this terrible time. Instead of understanding that the source of these scourges lay in their own habits and customs, they were attributed to divine wrath.

From such a benighted condition the world has emerged slowly, and, in fact, the shadows and mists of these old superstitions are not entirely dispelled at the opening of the twentieth century. All of us know people who pose as educated and intelligent and progressive citizens who insist that, if a water is clear, sparkling, and of good taste that it must be therefore perfectly pure and wholesome; that it is impossible to contract typhoid fever or other disease from such water.

The progress has been rapid during the last half century, but there is still a great work to be done in the education of the people. The teachers in this school are the scientific men working in chemistry, physiology, bacteriology, and the civil engineers. We

should let no opportunity pass without raising our voice in favor of pure water, sewers, and sewage purification. The tendency of the times seems to indicate that a larger and larger percentage of our population is to be gathered into cities. If such be the case, the danger of the pollution of our streams and lakes becomes greater, while the necessity of keeping them pure also becomes greater and more difficult. It will require an intelligent and educated public opinion to secure the desired ends.

RAILROADS.

It is claimed by some that the railroad track antedates the nineteenth century, but the locomotive is, without doubt, a production of the early years of that century. The first railroad approaching those of to-day was opened in 1825, although many writers place the birth of the railroad on October 14, 1829, when Stephenson's locomotive, Rocket, won its prize on the Liverpool & Manchester Railroad.

It is an interesting fact, not often referred to, that an English built locomotive began successful operation in Pennsylvania about two months before the contest at Liverpool.

America soon took the lead in railroad building and developments, and still maintains this proud position. The development of the railroad has been beyond all expectation, and is one of the wonders of the past century. It is impossible to analyze all its effects upon mankind and the nations of the world.

The railroad is, without question, one of the greatest achievements of engineering during the nineteenth century.

MACHINERY AND ELECTRICITY.

Of the introduction, improvements, and inventions in all kinds of machinery I cannot take time to consider, nor of the wonderful processes used in the production and manipulation of metals, nor of the wonders worked by the electric current. These things have been worked out by the engineer and his twin brother, the scientist. Each step forward has brought to view a much wider horizon and made other progressive steps possible until now, at the opening of the twentieth century, the horizon seems limitless and the room for progress unbounded. The boldest dare not prophesy what the century will bring forth.

What part will the civil engineer take in the progress of the new century? It must of necessity be a prominent and important part; and he must prepare himself for it by careful and thorough training.

Beofre the knight-errant of old could don his armor, buckle on his sword, and set forth to do battle for the principles he believed true, he had to prove his fitness for the honor and responsibility

by a long and severe course of training. So with the young civil engineer of the twentieth century.

I do not know how the great builders of the ancients were instructed and trained. The engineers of the eighteenth and most of the nineteenth centuries were either self-educated men or were trained under the apprentice system. The engineering school is a production of the last third of the nineteenth century. Its development has been rapid, and the usually generous rivalry has been strong. Each has striven to outdo its neighbor in the rapid but thorough preparation of young men for the work before them. Mistakes have been made, and will continue to be, made, but the advancement has been very marked.

The civil engineer of the twentieth century must be a thoroughly trained, broadly educated man; this fact is becoming more prominent every day. There has been, of late years, a tendency to narrow specialization, but it seems to me that this cannot be the best line of progress. The engineer must have a broad foundation upon which to build his speciality.

He must have thorough training in mathematics and mechanics, and in the underlying principles of all lines of engineering. He must know considerable chemistry, physics, geology, and all other sciences that have a bearing upon the matters with which he has to deal, so that he can put to practical use the discoveries that the pure scientist may make. The day is rapidly passing when the untrained young man can start on a corps as axman and work his way to prominence in the engineering profession. When he makes his start he will find at his side other young men who have devoted four or more years to study and mental training for the work they undertake, and he will find that they quickly pass him in the race for the top, and that others starting after him will also pass him on the way, leaving him sidetracked in some subordinate position.

Probably all of us know engineers of ability and broad reputation that have won their way without the advantage of a college training. Most of the great progress in engineering has been accomplished by such men, and all honor to them. But I predict that, by the time one-third of this century has passed, that such men will be very rare. It is the thoroughly trained man who will direct the engineering works of the new century. [Applause.]

The Chair: "The report of Professor Brown is now open for discussion. If there is no desire to discuss the paper, we will pass to the next. First, I announce as the Nominating Committee, Messrs. E. A. Kemmler, B. F. Bowen, and J. B. Strawn."

Mr. Wilson: "I would like to say, as we have a moment, a young man in my place asked my advice, recently, in reference to going to college, and whenever my advice has been sought in this regard.

I have always recommended a course in college. I feel, as Professor Brown says, that it is much better for a young man to have a college education, and it will become more and more necessary. So this has always been my advice in reference to that matter."

Mr. B. F. Bowen: "In reference to Professor Brown's paper, I do not know that it needs much discussion. I think it is fairly full in itself.

"It might be well to say, however, that conditions in the times he refers to were different from those of the present. In reference to roads, there has been much discussion in recent years about the subject of good roads in this country, and if I have any judgment on the subject at all, I think the matter has been overdone in the way of publications and information sent out over the country, to the effect that the produce which has been transported in this country costs the farmers at least 25 cents per ton per mile. This is evidently very misleading. It is out of place to discuss it here, but I am ready to maintain my position whenever it is proper to do so.

"At the time these perfect roads were made by the Roman empire, there was great necessity for good roads. In fact, they were compelled to have good roads both for military reasons and for commercial reasons. At the present day, there is not the necessity for making those kind of roads that they did then. I don't think there is a gentleman here but would think it preposterous to undertake to build a paved stone road from here to Cincinnati on a direct line. We have got a better, cheaper way of doing things; therefore, it would be unnecessary to build that kind of a road where there is no necessity for it. It would be the same in other directions. Take it from here to Toledo, from here to Cleveland, from here to Pittsburg, from here to Zanesville, or other surrounding towns—it would be unnecessary to make any expensive line of wagon road in those directions, for the reason that we have railroads. The good roads in England and in France which we hear about were built at a time when they were necessary. Those countries commenced making good roads two thousand years, probably, or at least one thousand years before the white man landed on American soil, and it would be strange if they did not have good roads by this time. I venture to say that even in those countries, which stand so far ahead of us in this way, they sometimes have bad roads, as we do here. Good roads are coming our way in this country, and they are better now than ever, and I venture to say that every decade from now on will find them better improved than the decade previous. I believe that wherever the necessity exists for improved roads, and the funds are at command to build them, they will be built, and they ought not to be built before. I do not believe that the man who owns a wheel, and that alone, should dic-

tate to the farmer when and where he shall build a road and pay for it. That much about roads.

"Another thing occurs to me in regard to canals for transportation. Much has been said about the building of a canal across the Isthmus. According to the accounts which we sometimes read, it would look like a herculean task, almost impracticable. When you consider that an ocean steamer will have to be raised one hundred feet above the level of the sea, and then, at the other end, let down one hundred feet, that would seem a tremendous task. But when we come to compare that with things already done, not far from our own home, we can realize that it is practicable. Go to the Welland Canal, where there is 410 feet fall between Lake Erie and Lake Ontario. There we have a canal which takes quite large vessels, and this 410 feet of rise or fall is accomplished in seven miles out of the twenty-three miles. On the first section it is a dead level; then the locks being—27 locks in seven miles. That does the business, and there doesn't seem to be any very great difficulty about it. There is tremendous traffic, and it goes as smoothly as clockwork; no difficulty about it at all, and nearly four times the lift there is on the other. So I believe it is perfectly practicable.

"The other points in the paper, I think, speak for themselves; and the only wonder in my mind is how the professor got the information he has laid before us. It is certainly of great advantage to me, and I shall be pleased to have the opportunity to read it at my leisure after the proceedings are published. The same in regard to Brother Strawn's paper."

Mr. Frost: "The paper by Professor Brown is so excellent and covers so much ground, that it ought not to be passed by without notice.

"In the last two years, I had the privilege of going over a good part of Europe, where the public works of which Professor Brown speaks are on view. First, regarding the roads: I agree almost entirely with the gentleman who just preceded me. There is no question of good roads coming along in the United States with fairly respectable rapidity, as everything is done in the United States. As he said, the roads of Europe have been some two thousand years in building. Some of the Roman roads are still in evidence. It is about two years ago, year before last, just about a month later than this, I took a road down above the Appian Way from Rome. I went down to the baths at Atilla, and I will just mention about those baths with regard to the steam heating. The hot water is still there, and everything is in very excellent order. Of course, the baths have fallen in, but all the apparatus for heating water is in very good condition, and when you think that six thousand people used to bathe at a time, you can understand that it was quite a place. Going back, we went over the old Appian

Way, over which was transported all the military movements and everything to the sea. It is still there, but is not used. There is another Appian Way off two miles north, and that is where the traffic is. The road itself (the old Appian Way) is about half the width of this room, and a good part remains as at the time of Cæsar. On each side it is lined by great tombs—it was a cemetery on both sides. The remains of the great dead were buried there on each side of the road, so when they came in on their triumphal entries they did so in full view of their great ancestors, whom they worshiped; so that it gave a magnificence to it that we do not understand, perhaps. In the remains of the city of Pompeii, it looks like they never repaired the roads. A few streets were given to traffic. They were laid with broad, flat stones, and the streets were about as broad as four chairs. All moved in the same direction. There was no passing. There had to be some sort of signals where another would come in, as there could be only one team at a time. These stones were worn down in some places sixteen inches. This would indicate no repairing, so I suppose the engineering was cheap work.

"As Professor Brown says, it is one of the things which strikes you very strangely when you come along Pompeii and find evidence of sanitary work, evidence of plumbing. They have taken up pipes and laid them on the wall, to show the character of the pipes. In the interior court of the houses, where the water ran, you find the plumbing, almost identical with what we have now. When you go to Naples, it strikes you that there is nothing new under the sun, and many things they were using we have not improved on yet.

"You find, in the southern part of France, the best roads in the world, though they are good all through France. They are tourists' roads, with no heavy traffic. They are almost entirely given up to Cook's tourists, and it is rare to see a heavy wagon. On a French road, every little ways you will find a man with a little pile of stones, and they are constantly repairing. If a little hole occurs, they don't leave it an hour, but repair it at once. The road is the finest road in the world. I drove over it one day, and it is certainly most magnificent. There you find the very perfection of road building. It climbs up over high mountains. There must be most careful grades to do this in comfort, and you drive down the mountain and go to Monte Carlo. These roads are built entirely for pleasure driving, and are the finest in the world. The roads are kept up because this is the resort of the very wealthiest people of Europe, and it is the finest, most lovely place, I may say, to go. So when you come to talking about good roads in Europe, you have got to realize there is something besides merchandise traffic to go over them. There is hardly any merchandise traffic on them. Immediately you get over the Italian border, you

find poor roads. The result is, that where there are hundreds of people driving around in France, when you get over the border into Italy, you don't go out so much through the country, and depend on going around in Rome and such cities.

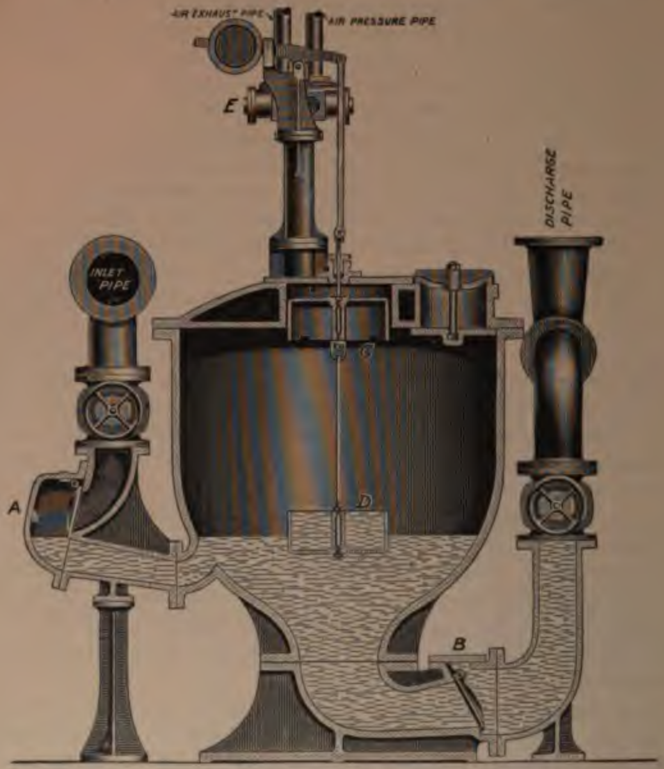
"It requires much money to build good roads—more money than the farmers of the United States can raise in taxes, to build such roads as you find in England and Scotland, because never a tourist goes over the road, except a wheelman may occasionally.

"As has been said, there are many bad roads in Europe. Where the soil is naturally good, as in Switzerland, the roads are very nice. It is like a great park. They have got to provide for tourists. The Swiss themselves don't keep horses; it costs so much, they make the women draw the carts. In walking up the street in Berne, a street a mile long, I called the attention of my wife to the fact that there was not a horse in sight, nor a carriage, on an ordinary day. Compare that with the traffic in Columbus or New York. There are pretty rough roads in the city of Berne, too. They have pretty nice roads through parts of Switzerland, too, but everywhere you see the men, boys, and women drawing the carts. They are kept pretty busy getting what they can from the tourists. The roads are not good in Germany and in Holland. You travel over brick roads right around out on the level plains, and the boats sail right beside you, for the canals are everywhere. They don't build brick roads as we see here, but they are very good.

"In England and Scotland, we find a very fine system of roads and canals.

"It is rather interesting, in Rome, to see the remains of one old bridge, a section built at the time of Cæsar. Everything reminds you of Cæsar. But the conditions there and here are very different. Now it is a fact that though the Pilgrims came along in 1620 and 1630, it was not until 1830 that anything was done in Massachusetts. In 1830 was the renaissance of Massachusetts and the United States, when the railroad came along. Life was, up to this time, very primitive. Any man now sixty years of age, who knows anything about the Puritan life of the East, will recognize the fact that, up to 1830, there was comparatively little change in the life of the primitive country.

"This paper of Professor Brown's is exceedingly interesting, and reviews these matters so clearly that it has been a very great pleasure, indeed, to listen to it; and especially to one who has seen some of these things and realizes the conditions. I am very glad I was present to hear it."



THE RIVERDALE SEWERAGE SYSTEM AND THE SHONE PNEUMATIC EJECTORS.

By Frederick J. Cellarius.

Dayton is one of the first cities of Ohio to adopt the separate system of sewers, and to-day has fifty-five miles of sanitary sewers, and rapidly increasing that number every year. About fourteen miles of this system were contracted for and laid during the past summer and fall. The opposition encountered during the first introduction of sanitary sewers has nearly all passed away. The benefits derived, promoting a permanent growth to the parts of the city enjoying its advantages, are plainly noticeable. Again, from a business standpoint, the citizens know that the continual expense for cleaning vaults will soon exceed the amount of the small tax for sewers, with nothing in return for the one, and a valuable permanent improvement for the other. Real estate men will tell you

that well-to-do citizens contemplating the building of homes for themselves will not locate in the localities not sewered, and the result has been the rapid extension of our sanitary sewer system, which is giving general satisfaction. They regard it as essential to the health and prosperity of any section. Our best citizens do not fancy the idea of living in a section of the city honeycombed with vaults and cesspools, impregnating the soil with deposits which produce disease and death. To overcome this condition, the citizens of Riverdale, one of Dayton's beautiful suburbs, petitioned the Board of City Affairs and the City Council for the sewage of that suburb.

Riverdale has a population of from 4,000 to 5,000 people. The entire territory borders on the Miami and Stillwater rivers, the Miami River separating it on the south from the central portion of the city. (One-half of this territory is too low for a gravity sewer outlet, because the sewage must be conveyed across the river, using the same outlet constructed for the central portion of the city, which outlet is the Miami River, at the southern extremity of the city limits. This outlet was approved by the State Board of Health, which has been a legal requirement in this State since 1891 to the introduction of any system of sewage. To accomplish this, and to avoid pumping as much as possible, a high or gravity line and a low line of sewers was constructed in Riverdale, with a difference of 5.50 feet in the elevation of the two lines at the point where they cross the Miami River. To overcome this difference in elevation, 1 in 350, two Shone ejectors (duplicates) were placed at the corner of Lehman and Hydraulic streets, the lowest point in Riverdale, lifting the sewage from the low line into the high or gravity line, and then both lines flow by gravity across the Miami River through an inverted iron siphon ten inches in diameter, having a hydraulic gradient of 1 in 350. The outlet sewer on both the high and low lines consists of twelve-inch vitrified sewer pipe, the submains of ten- and eight-inch, as shown on the plans. Nothing less than eight-inch pipe was used. All sewer pipe used was three feet in length, with sockets three inches deep. This length of pipe, with the deep sockets, was used in order to lessen the number of joints, and the better to cement them, and thus to reduce the seepage to a minimum, as the elevation of the sewer in the low line is about low water mark in the Miami River.

The cementing of the joints was also watched closely on account of the roots of the North Carolina Poplar, with which many of our streets are planted, finding their way into the sewer pipe if but a small crevice is left, and completely closing the pipe within a short time with a fine, threadlike growth of roots.

The Hydraulic Race is crossed three times by an inverted iron siphon, one of six and two of eight inches in size.

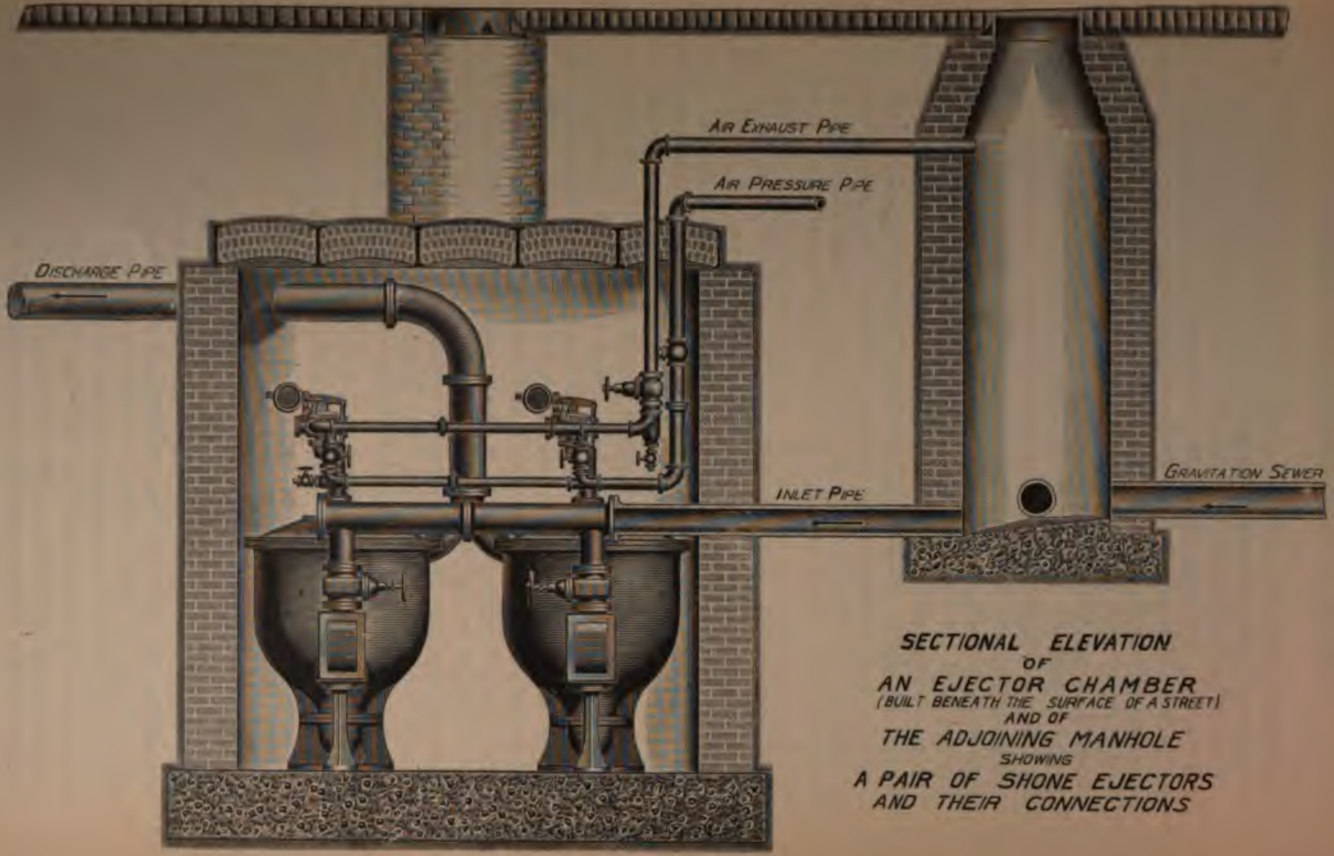
Man-holes on straight lines were made elliptical in shape, 3x4

feet, with channel pipe through them. Junction man-holes were made circular $3\frac{1}{2}$ feet in diameter.

Flush-tanks are 4 feet in diameter, the Miller automatic siphon being used, which has given good satisfaction in our other sewers.

House connections are 5 inches in diameter. In nearly all cases the sewer was placed in the streets and below cellar floors. The excavation varied from 5 to 14 feet. Portland cement mixed in the proportion of one measure of cement to one of clean sand was used for the joints on part of the work, but, on account of the difficulty of getting clean sand, Buffalo and Utica hydraulic cements were used neat for the balance. Stakes for the alignment of the sewer were driven on the left-hand side of the sewer looking toward the higher level, 3 feet from the center line and 25 feet apart. Grade lines were given every 25 feet in the trench by means of iron stakes $2\frac{1}{2}$ feet long, the tops of which were set 2 inches above the cylindrical part of the pipe. A line was stretched over these stakes, and, by means of a 2-inch gauge, the pipe was set to grade.

I have placed on the wall before you a map of the territory, together with the plans and profiles, and will therefore not go into a detailed description of them. But there is one feature of the system of which I want to speak, as it deserves special mention, and that is the Shone System of raising sewage from a low level to a higher one, by means of a pneumatic ejector. This is an automatic appliance for pumping the sewage by compressed air. Dayton is, perhaps, the first city of the State to use it. The problem presenting itself in the sewage of Riverdale was, how to give the low-lying territory a perfect system of sewage. Natural gravitation was out of the question. To discharge all the sewage into one common cesspool or vault, and then pump therefrom by means of a steam pump is objectionable and offensive to the neighborhood in which it is placed, is not self-cleansing, is unsanitary, and requires a constant attendant. By the Shone Ejector System all of these are avoided. All the sewage from the low territory is conveyed by gravity through ordinary sewer pipe to the corner of Lehman and Hydraulic streets, where two Shone Pneumatic Ejectors (duplicates) are placed in a cast-iron water-tight chamber 12 feet in diameter. This cast-iron chamber rests on a bed of concrete eight inches thick, and consists of thirty pieces of cast-iron circular parts bolted together by means of $\frac{7}{8}''$ bolts and then caulked with $\frac{3}{4}''$ extra strong lead pipe, making it perfectly water-tight. The bottom of the chamber is twenty feet below the surface of the ground, where located, and the water would rise nine feet in the chamber if admitted. It is located at the intersection of the two streets, and has an ordinary two-foot iron man-hole cover on top, which is all that can be seen of it from the street. These ejectors have a capacity of 340 gallons each per minute, and are



SECTIONAL ELEVATION
OF
AN EJECTOR CHAMBER
(BUILT BENEATH THE SURFACE OF A STREET)
AND OF
THE ADJOINING MANHOLE
SHOWING
A PAIR OF SHONE EJECTORS
AND THEIR CONNECTIONS

to be used alternately every week, to keep the flow-pipes, which are connected, from becoming clogged.

The lift at ordinary stages of the river is 5.5 feet, and, at high-water stage, 18 feet. The sewage is conveyed into one of these, and, when filled, compressed air is automatically admitted, forcing the sewage into the high or gravity line. The outlet of the ejector being from the bottom, all the sewage, including everything brought down the sewer, solids and all, is discharged out of the ejector chamber. If you have the supply, a 340-gallon ejector will fill and discharge itself in about one minute.

The power in this case is derived from an air compressor actuated by steam placed in the Water Works Pumping Station, and conveyed by a 4-inch cast-iron pipe a distance of 6,000 feet to the ejector. The reason for placing the air compressor at the Water Works Pumping Station is because it is owned by the city, and requires no additional help to run it. When first operated, owing to various improvements under way at the Water Works Pumping Station, where the air compressors are located, continuous running of the compressors could not be secured, so we were compelled to allow the sewage to accumulate for from twenty-four to thirty-six hours, when they were started, and the sewage expelled. Not many connections having been made, this could easily be done. This mode of disposal required daily attention, until the improvements at the Water Works Pumping Station were completed, but now they are running constantly. The flow into the ejectors is not very heavy as yet, but by means of a heavy usage of the flush-tanks we manage to operate the ejectors every twenty of thirty minutes.

The only condition that would cause the ejectors to fail to operate would be the introduction of some hard substance, such as a lead pencil or small stick, and its being caught under the back pressure gate, in which case the air valve would remain open. The increased speed of the compressors would then indicate this trouble at once. To remedy this, start the ejector not in use, close the valve of the disabled ejector, and remove the obstruction.

The action of the apparatus is as follows:

The sewage gravitates from the sewers through the inlet pipe A into the ejector, and gradually rises therein until it reaches the under side of the bell D.

"The air at atmospheric pressure inside this bell is then enclosed, and the sewage continuing to rise around it, its buoyancy is sufficient to lift it with the spindle, etc., and to open the compressed air admission valve E. The compressed air thus automatically admitted into the ejector presses on the surface of the sewage, driving the whole of the contents before it through the bell-mouthed opening at the bottom, and through the outlet pipe B into the high-level gravitation sewer. The sewage can only escape from the ejector by the outlet pipe, as the instant the air pressure is ad-

mitted upon the surface of the sewage the valve on the inlet pipe A falls on its seat and prevents the fluid escaping in that direction. The sewage passes out of the ejector until its level falls to such a point that the weight of the sewage retained in the cup C, which is no longer supported, is sufficient to pull down the bell and spindle, thereby reversing the compressed air admission valves, which first cuts off the supply of compressed air to the ejector and then allows the air within the ejector to exhaust down to atmospheric pressure. The outlet valve then falls on its seat, retaining the liquid in the sewage discharge main; and the sewage flows through the inlet once more, and so the action goes on as long as there is sewage to flow. The position of the cup and bell is so adjusted that the compressed air is not admitted to the ejector until it is full of sewage, and the air is not allowed to exhaust until the ejector is emptied down to the discharge level. Thus the ejector discharges a specific quantity each time it operates."

Mr. Bowen: "Do you know of these ejectors being used on a large scale?"

Secretary Cellarius: "They were used at the World's Fair, where they actually disposed of 24,000,000 gallons per day. There were twenty-two different stations where the sewage was collected and disposed of by the Shone Ejectors, as the sewage was treated before emptying it into the lake. Perhaps the next largest system to the one used at Chicago is at San Francisco. Ithaca, New York, has a 600-gallon ejector (in duplicate). I may say that these ejectors are always placed in pairs. Whiteplains, New York, has one of 300 gallons, where the sewage is raised ninety feet. Dayton has one of 340 gallons. I believe there are six or seven different sizes of the Shone Ejector, varying from 100 gallons to 1,000 gallons per minute. They are also used quite extensively in Boston, New York, and Chicago, in large buildings where the cellar floors are below the sewer level."

Mr. Frost: "How many gallons of sewage per day are taken up by these ejectors?"

Secretary Cellarius: "These ejectors at Dayton have a capacity of 340 gallons per minute, but they do not discharge themselves every minute, though they can do it. An eight-inch pipe will fill the ejector in 50 seconds and empty it in about 10 seconds. They will fill and discharge in a minute, if they have the material. But in our case, at the present time, it takes about a half-hour to fill and discharge. It depends upon how many connect with the sewer, and how often per day the flush-tanks are working."

Mr. Peters: "I would like to ask the gentleman if any provisions are made, or what they are, to take care of the sewage, or

prevent great damage, in case the working parts should get out of order?"

Secretary Cellarius: "The high line does not connect with the low line, but goes right across the river through an iron pipe by gravity. In the low line, the only provision made is duplicate ejectors, so if one is out of order, the other can be used."

Mr. Peters: "Will one take up the work automatically if the other gets out of order?"

Secretary Cellarius: "No. One must enter the ejector chamber and start the ejector not in use and close the valve of the disabled one, which takes but a few minutes, in which time no damage can be done."

Mr. Bowen: "Is the compressed air supplied constantly?"

Secretary Cellarius: "Yes, sir."

Mr. Bowen: "And automatically?"

Secretary Cellarius: "Yes, sir."

Mr, Bowen: "So it is always in working order?"

Secretary Cellarius: "Yes, sir; always in working order."

Municipal Improvements of Shelby, Ohio, During the Year 1900.

BY J. B. WEDDELL.

To the O. S. of E. and C. E., Columbus, Ohio:

BROTHERS: In the following statements I have tried to be brief, and yet leave out none of the essentials, in a synoptic way, of the construction of certain municipal improvements made in Shelby, Ohio, during the year last past.

They were the laying of 20,873 square yards of sheet asphalt, 1,300 square yards of macadam, bordered by 14,823 linear feet of artificial curb and gutter, the building of three miles of sanitary and 2,700 linear feet of storm sewers, the building of sewage purification works, and the partial construction of the terminal of The Citizen's Electric Railway of Mansfield, Ohio.

PAVING.

Bids were asked for brick and asphalt, with both natural and artificial curb.

The general requirements of the specifications were:

A 5-year guaranty on both brick and asphalt.

A 5-inch concrete base—natural cement.

Asphalt (if sheet) 1½ inches of surface on 1 inch of cinder.

Grout filler in brick.

10% retainer on partial payments.

Cash in full, including retainer, when work completed and accepted.

Analysis of proposals showed the lowest and best bid for brick to be 7 cents below lowest for asphalt.

Property-owners filed petitions with Council stating their preference of kind of paving, which showed a large majority of front feet for asphalt.

The award (except for macadam) was made to the Ayers Asphalt Paving Company, of Zanesville, Ohio, for Trinidad Lake Asphalt and artificial curb and gutter, whose bid estimated a total of all items of $1.98 per square yard, whole work complete.

The excavation amounted to about 16,000 cubic yards.

A short street, 600 feet in length, was improved; 22 feet wide between curbs, with 9 inches of macadam bordered with artificial curb and gutter, of same cross-sections as shown upon above diagram, and cost, for the whole complete, all items, $1.15 per square yard.

SANITARY SEWERS.

These are all eight lines, and were contracted to W. J. Townsend & Company, of Cleveland, Ohio, for labor only, except the brick for accessories, whose proposal was 48 cents per lineal foot of sewer, $26 for man-holes, $38 for flush-tanks, and $3 for lamp-holes.

The trenching averaged 10 feet deep.

STORM SEWERS.

3,600 feet of 12-, 15-, 18-, 20-, and 24-inch pipe, and cost, in round numbers, $2,700.

PURIFICATION WORKS

are built on the intermittent filtration plan, and, at present consist of two filter beds and two storage reservoirs, with plan for others when needed.

One bed is 60 feet wide and 175 feet long; the other is 140 feet long—one end 60 feet and the other end 155 feet—being a surface of 25,480 square feet in both.

The beds are underdrained with 6" sewer pipe laid in straight lines 20 feet apart, with unsealed joints wrapped in one thickness of cheese-cloth, with lamp-holes at each end, and all gathered into a 10" line connecting with the outlet.

The filtering material is two feet deep along the lines of underdrains and 18 inches in center between drains.

Owing to the difficulty of obtaining enough of suitable gravel to fill the entire area of the beds, each drain was overlaid the full depth 6 feet wide with gravel, and the spaces between filled with good coal cinders.

RESERVOIRS

are each 10 feet wide, 21 feet long, and an average depth of 6 feet.

They are lined and bottomed with vitrified brick laid in good mortar and covered with a tight board top divided into four sections. Screens are placed to intercept and hold all supernatant matter and coarse solids from passing the filters.

Distributing trenches of 10″ and 12″ half sewer pipe lead to different parts of the beds.

The works were opened for use about November 1, and treated daily 200,000 gallons sewage, which was greatly diluted.

Samples of crude sewage as it entered the reservoirs and of the effluent at the filter outlet were taken, and show a highly satisfactory result—exceeding expectations.

The following is the total cost of the works:

Filters—Gravel, 550 cu. yds. @ 40c	$220 00
Cinders @ 10c	71 00
Labor and pipe	1944 55
Reservoirs—L. & M.	710 70
Engineering and incidentals	100 00
Total	$2746 25

Views of the filters taken from different sides are herewith attached, and also a print of detail plans of the work in section.

It is the opinion of the writer that sewage purification works, upon the above plan, are within easy reach of all smal ltowns and cities, being the cheapest and best method where land and material can be obtained at small cost.

After completion of his paper, Mr. Weddell entered into an explanation of some drawings on the blackboard, illustrating the general plan of the sewage purification works at Shelby, Ohio.

Continuing, Mr. Weddell said: "The works are not now in use, because of the season, the intention being to use the works during the summer months, from the first or middle of April until probably the middle of December; then turn it from the place of distribution into the main channel and let it run on. This sewer [indicating on drawing] is of the same size as the main outlet connected with the reservoir.

"I have photographic views of the filters here which any one who wishes to do so may examine, and also plans of details of construction of the reservoirs and beds.

"I also have here a set of specifications which contain the figures of the proposal of the contractor for the work."

Mr. Kemmler: "Do you know what rate of purification you got from the beds when you made an analysis?"

Mr. Weddell: "There was no analysis made other than what we concluded from appearances. It being where no water is taken from the stream for domestic purposes, about all the requirements necessary would be to meet with the approval of the people in that locality, which would be accomplished even if the appearance were not so good as the effluent showed. The effluent was as clear as anything could be. In fact, the stream into which the effluent was

turned is a very dirty stream. A tube works turn in an acid which colors it a brick color, or yellow color, for miles, and kills all the fish."

Professor Brown: "I would like to ask, what is the use of the two tanks?"

Mr. Weddell: "To gather the solids until such time as they need cleaning. The solids are held there."

Professor Brown: "Does the sewage run through the tanks on to the beds continually?"

Mr. Weddell: "Yes, sir."

Professor Brown: "Do you change from one bed to the other?"

Mr. Weddell: "Yes, sir."

Professor Brown: "At what intervals?"

Mr. Weddell: "That will be done as judgment may determine or dictate."

Mr. Strawn: "Did I understand that the cost of that engineering was a little over a hundred dollars?"

Mr. Weddell: "The engineering was done in connection with other work. The engineering there was the work done upon its construction principally."

Mr. Griggs: "How many times are the tanks filled?"

Mr. Weddell: "As they rise and are filled, they overflow."

Mr. Griggs: "What relation to the quantity of sewage?"

Mr. Weddell: "Do you mean what proportion of solids to the amount of water?"

Mr. Griggs: "No; I mean how many gallons of sewage a day, and what is the capacity of the tanks?"

Mr. Weddell: "The tanks do not hold much, but are more to gather the solids as they come along than for any other purpose; and when that needs to be taken out, one is closed and the other is put in use. It is pumped out, deodorized with crude carbolic acid, distributed upon the land, and plowed under."

Mr. Griggs: "What population is served with this plant?"

Mr. Weddell: "About five thousand population, but all are not connected with the sewer."

Professor Brown: "How long was it in use this fall?"

Mr. Weddell: "About a month."

Professor Brown: "What was your experience as to the top? Was there any collection of sediment on the top of the cinders?"

Mr. Weddell: "But very little. It disappeared in a little while after it was turned off."

Professor Brown: "So the per cent. is the same apparently as in the beginning?"

Mr. Weddell: "Yes, sir."

The Chair: "Mr. Frost is with us this evening, and I understand the subject of sewage disposal is a favorite one with him. We would like to hear a few words from Brother Frost."

Mr. Frost: "Mr. President and Members of the Society: I cannot say that I am an expert on the subject of sewage disposal. I first became interested in the matter of sewage disposal through the construction of the Plainfield sewage system. There we have a farm of fifty-one acres, of which about seventeen are put into the sewage disposal works on the principle of downward intermittent filtration. There is probably nothing yet produced which is able to take the place of downward intermittent filtration.

"The British government, which set the standard of purification of water the highest in the world, perhaps, has insisted that, no matter what system of sewage disposal is used, that the final disposition is that it must be returned to the land by a system of downward intermittent filtration. The great trouble has been to get rid of the sludge. That has been the great bugbear of sewage disposal. In the British societies, more than in this country or any other country, perhaps, the subject of the disposal of the sludge has been discussed by the principal sanitary engineers of England.

"I suppose I am talking to men who keep pretty well along with the subject, and who are, perhaps, quite as familiar with it as I am; but it has been my good fortune to be able to visit personally some of the principal sewage farms in England, and also the latest fad, that of the septic tank and contact bed.

"Speaking about this thickness, the depth of the material that Mr. Weddell placed in the Shelby bed, a year ago last August, at a convention in London, among other discussions, was one regarding sewage disposal works which take the Middlesex side of London. You understand that the sewage of London is so enormous that it is beyond our conception. There is an experimental bed of one acre at the works, where one million gallons of sewage is disposed of in twenty-four hours. The sludge is first deposited, however. All the sewage that comes down goes through the liming process, and is turned to these beds. It takes a fleet of thirty vessels to take away the sludge, each vessel carrying one thousand tons of sludge. When you land on one of these vessels, you would not suspect that there are there one thousand tons of indescribable filth in the hold—it is so clean and nice. When you go onto these beds, you neither see nor smell sewage. The sewage is brought in from below, and the gauge shows you just how high it is. So it would seem from that that you can get very good sewage disposition without great expense. Walking back to the train with the resident engineer, he said there were five feet of stuff on that bed, and he really thought it injured the working of it; he thought a reduction of one foot in thickness would be better, but not more than one foot. C——— said to me, and he is one of the leading authorities in England, 'You want to make a note of that, for it is a very important assertion.' He said he had decided that four feet was the minimum depth which should be put over the drain pipes, and.

while many people put five or six feet, four feet were sufficient. If, as Mr. Weddell says, they only want to change the color, so the people will be satisfied, it doesn't make any difference, if they can hold the cinders down. But if you are undertaking to attain any standard of purification, the two feet would be of no good whatever. I think the depth should be four feet, and five feet when the effluent is used for drinking purposes.

"Over a great part of London the drinking water is taken from the Thames, and the effluent from the sewage farms goes into the Thames, so it is necessary that it be thoroughly purified.

"The septic tank at Exeter has become celebrated. Perhaps I am repeating what you may know, still one wishes to become familiar with these things. Exeter, it may be remarked, was the first city in England to adopt a sewage system, and now it is the first to adopt this septic tank system. It is an experimental process, and the whole area of the experimental system is not larger than this room—not as large as this room, land, tank, and everything combined. It is a very nice example of what can be done for hospitals, public institutions, schools, large private residences, on farms, and places of that nature. And I think it might be well to impress upon the people, upon the younger engineers, that there is not a field of so great promise for emolument to engineers as the disposal of sewage and purification of water, I think most especially in the disposal of sewage. I think the study of the disposal of sewage will be about as profitable to the young men as any branch of engineering he can well take up. The legislation of the country is tending all the time toward the purification of our rivers and toward the prevention of pollution of the same. Under the laws of New Jersey, we have got to purify the sewage, and it is coming that way in many other States. I think it is coming that way in Ohio. So it is becoming one of the living questions of cities, what to do with the sewage and how to purify it. That is now a vital question in this city, and I think the city authorities are acting wisely in waiting, because we have not got to the very best thing yet in the way of sewage purification.

"This septic tank, however, is a very nice thing, and the originators of it are very enthusiastic in its use. No doubt, in this country it will come along more rapidly than in England. England now has only two experimental tanks, and my city, Plainfield, has started to build the largest in the world. The septic tank system is not having the progress in England that it has here. England is very conservative. In order to get money for such improvements, they must go before the Local Governing Board, and then they can't always get it. It was not approved at Exeter, so it was undertaken in this experimental way without aid. In this country, we have several small plants—all very small. This at Plainfield, if the plans are carried out in their entirety, will be the largest in

this country. Mr. Cameron, the patentee of the septic tank system, is a very excellent engineer, and naturally has very great faith in the system, and they are going to arrange for the disposal of all the sewage of Exeter on that basis. I think it is the coming thing, even in this country in small interior towns. It takes up very little ground—is nothing but a great cesspool, a tight cesspool, in which the heavier material is intercepted, and depends for its success on the bacteriological process. One class of bacteria takes possession of it and breaks down the solids, and this is deposited, and you don't have any sludge. So that seems to be the most feasible disposition of sludge. There is so little sludge, and it can be so easily disposed of, that it practically does away with that problem. After the disposition of the sludge, the material runs out over an ærating area, and there another class of bacteria takes possession.

"Speaking of the sewage disposal problem here in Columbus, summer before last I was at Birmingham, where they have a farm four miles long and one mile wide. They have large works, with big pits in which the sludge is deposited and dug out with steam dredges and carted away in dump carts and deposited on the land, where it is dug-in one acre a week, until they have covered the ground (156 acres), when they return to the first ground. They raise large crops there, but it is a horrible place, I must say. I would not want to live there. There is only a small part, of about a thousand feet, that is somewhat offensive. On the rest of the four miles you would not know anything about it. They expect to increase it. It is an enormous thing, employing sixty men. If the land is suitable about Columbus, there might be an opening for this system, but the question has been discussed by men far abler than I am to discuss it, so I am not giving any opinion in regard to Columbus. But before going into sewage farming in this country, we have got to bring in men trained on sewage farms. You can't take ordinary farmers and put them on sewage farms and have them work successfully. They have got to understand the proper crops which are adapted to this kind of farming, understand when there is an excess of water, and so on. We have got to have men from the English farms or the vast farms in Berlin. I don't think so much of the French farms, as they use the farms for raising vegetables for the Paris markets more than for any other crops.

"As I remarked before, I think there is no more practical study to-day than the careful study of the disposal of sewage for young engineers. It is really just in its infancy. There are going to be many small systems in the interior towns, where it will not pay the big experts to go, but for engineers in centers like Columbus there will be a large field in Ohio."

Mr. Strawn: "Did you ascertain the cost of the works per thousand inhabitants?"

Mr. Frost: "No; I don't think the cost of them is given. Under the laws of Great Britain, the details of such improvements have to be gone into very minutely, and the literature of the Exeter tank is very voluminous, on account of the examination of experts, and so on, and that can be secured by addressing Mr. Cameron, of Exeter. They have an agent here, and have taken out a patent here. This system at Plainfield is going to cost about forty thousand dollars; the population is about twenty thousand. Mr. Osgood is going to advertise for bids for the tank this week or next, and it will cost, the first one, about ten thousand dollars. The ground is there, and all they have to do is to put the material on it. They expect to spend about that. They have not put that in public print, but I know from the engineer. The original cost of the intermittent filtration beds at Plainfield was about thirty thousand dollars. This new system will take care of a million gallons, twice what we are running now. It is an exceedingly nice thing, because it is all covered in and out of sight. I think much of the offensive smell coming from sewage disposal works comes because the people look at it; before they get a spoonful of sewage in the beds a farmer will hold his nose when going past the bed—purely imagination. I think if a good, high fence were built around it, the farmer would not have smelled it."

Mr. Weddell: "In reference to the thickness of that filtering material, some time before that thickness was determined on, we had a meeting at Cincinnati. While there, we went to the station where they were taking water from the river and delivering it to the people by their process. I think they had fifteen tanks there holding a hundred thousand gallons each. Some had five, some three, and some one foot of sand; and they said that the tank having one foot of sand in it gave as clear, pure water as the one which had five in it. The water was quite dirty there, and it was necessary to take off an inch of material from the top and replace it occasionally. If this was true there where they were using the different for drinking water, and getting a result so satisfactory for this purpose with these filters, we thought we could build filters of two feet so much cheaper, and certainly get the results necessary in our case. This would induce places to take up that kind of a method and put in that kind of work that otherwise would not feel able to do it. That is one of the feats of engineering to-day—not so much the building of great works as the giving to the people what they need at the lowest possible cost."

Mr. Frost: "The process of sewage purification is not one of straining; it is a process depending upon the bacteriological action, and the two great essentials are time and oxygen, and if it is put through too fast you don't get the effluent pure. You have got to have time and you have got to have oxygen in order to give the bacteria time to work. People have an idea that the filter bed is a

straining process. It is not a straining process, but depends on these minute organisms which feed on the sewage, and you must give them time to do that feeding, which you do not do if you put it through too fast. There must be time given for the accomplishment of this work. When water is put on, it takes about seventeen days to do the work. That is increased by inoculation or vaccination—taking some from other beds and putting it on hastens the process."

"If there is no desire to discuss this subject further, perhaps there may be a wish to further discuss the matter of legislation, which was brought up last evening and laid on the table. If so, time will now be given."

COMPARISON OF METHODS OF COMPUTING EARTHWORK.

BY PROF. W. H. BOUGHTON.

A. SCOPE OF THIS ARTICLE.

1. A treatment of problems arising in railway work would be a fairly complete treatment of the whole subject of earthwork calculation, for railway work presents samples of about every class of earthwork problems. In order to make a comparison of methods of calculation it will be sufficient to confine attention to the formation prismoid. The special problems on the same, such as side hill work, widening for sidings or additional tracks, flattening for slopes and correction for curvature would not affect the conclusions to be drawn, and they will not be considered. Neither do ditches, crossings and foundation pits require treatment. Borrow pits might fairly receive some attention, since different methods of calculation are used, but such discussion of them as needs to be given occurs in the treatment of the formation prismoid.

2. Definition of Prismoid. Many definitions of prismoid are given, the oldest being quite restricted and the latest quite broad. All insist on a solid having two parallel faces. Some require these faces to be dissimilar but of the same number of sides; others make no such restriction. Some require the other faces to be planes; others permit warped, cylindrical and conical surfaces. As the common prismoidal formula applies to all these solids, we may as well include them in the definition. A prismoid, therefore, is a solid having as bases two parallel polygons, and the other bounding surfaces being such that all the dimensions of any section parallel to the bases are linear functions of the distance from either base, and therefore the area of the section either a linear or quadratic function of the distance from the base.

B. DESCRIPTION OF METHODS.

3. Prismoidal Formula. $V = \frac{L}{6 \times 27}(A_0 + A_1 + 4M)$ Where V=volume in cu. yds., L=length between parallel bases, A_0, A_1

and M=areas in sq. ft. of the ends and a section midway between the ends.

The proofs of this formula have varied with the definitions of prismoid. When all bounding surfaces are planes, the solid may be divided by planes into prisms, wedges and pyramids all having one dimension=L.

The simple expressions for the volume of these can be written in the form of the prismoidal formula, which is therefore true of the whole solid. Another method is to join any point of the midsection with all the vertices of the solid, thus dividing it into pyramids. The simple expressions for these are written and combined appropriately to give the formula desired.

Under the broader definition of prismoid adopted here the proof runs as follows: Write an expression for the area of a section parallel to the bases. It will be a function of the dimensions of one end and its distance from that end. Regard this distance as a variable and integrate the expression between the limits O and L to get the volume of the solid. The result can be shown identical with the formula above.

The use of this formula requires to compute the end areas from the dimensions taken when cross-sectioning and the middle area from the means of the end dimensions.

4. Henck's Formula. For three level work. $V = \frac{L}{6 \times 27} [(d+d') c + (d_1+d'_1) c_1 + D C + D' C' + \frac{b}{2} (h + h_1 + H + h' + h'_1 + H')]$ where V=vol. in cu. yds., L=length, C=center height from surface of ground to road bed, d=horizontal distance from center stake to slope stake, h= height from slope stake to road bed. Accents distinguish right and left sides, subscripts distinguish first and second end sections, capitals D, C and H are dimensions at extremities of diagonal surface lines. Linear dimensions all in ft.

This formula applies to cases of all bounding surfaces planes, and it is necessary to note position of surface lines while in the field. It is proved for the portion of solid on one side of center line by drawing lines from one slope stake to all the other vertices, thus dividing the solid into pyramids; the simple expressions for these are combined and generalized into the formula as given above for both sides of center lines.

This formula is adapted only for three level work. When intermediates are recorded, Henck passes vertical planes through all surface lines to the plane of the road bed, thus dividing the solid extended into truncated triangular prisms all having one base on the road bed, and the lateral edges being the various center and side heights. These prisims are computed separately and added, and the two frustums outside the required solid, lying between the slope planes and the road bed, are deducted, giving the final result.

5. **Davis' Formula.** This formula was learned from Prof. J. B. Davis, of University of Michigan, and as far as the writer

knows has not been published. $V = \frac{L}{27} [\ \Sigma\ (h \frac{1}{6}\ \Sigma d) - \frac{b^2}{4s}]$ or $V = \frac{L}{2} [\ \Sigma\ (\frac{1}{9} h \frac{1}{9}\ \Sigma d) - \frac{b^2}{54s}]$ where V and L are as before; h=height of any record point of a cross section above slope plane; d=horizontal distance from any record point to next record point, right or left, on same cross section; b=width of road bed; s=ratio of slopes horizontal ÷ vertical. Linear dimensions all in ft.

Σd for any h=sum of the d to right and the one to the left of the given point on same cross section together with all d's on the other cross section included between ends of surface lines that run to given point on first cross section.

On three level work there are only two h's to be used, the heights at slope stakes being equal to zero. This formula applies to the same kind of solid as Henck's, but is not restricted to three level cross sections. To prove the formula, consider the solid between the end sections, the surface of the ground and the slope planes extended to an intersection. This is divided into pyramids, but not having a common vertex as in Henck's proof. One of these is peculiar and may be called a double wedge having its length=L and one edge in each end section. The simple expressions for these pyramids are combined and generalized into the compact form of the first term of the formula and the volume of the grade prism $(= \frac{L}{27} . \frac{b^2}{4s})$ subtracted.

In five level work where the intermediates are taken at the edges of the road bed, use *center* heights to road bed as ordinarily taken and omit the subtractive term in formula. Omit this term also for borrow pits:

If cross sections are irregular beyond the road bed, the h's for such intermediates should be figured to slope planes, while the heights at center and at edges of road bed may be taken to road bed only and the last term of the formula again omitted.

6. Mean End Areas Formula. $V = \frac{L}{2 \times 27} (A_0 + A_1)$ where the notation is the same as before. This is equivalent to considering each end section as extending of the same size to mid-length. No proof can be given, of course, as the formula is only approximate.

7. Mean End Areas with Prismoidal Correction. For three level work $C = \frac{L}{12 \times 27} (c - c_1) [(d + d') - (d_1 + d_1')]$ where C= correction in cu. yds. to be subtracted from result found by mean end areas formula to get the correct volume.

Other notation same as in Henck's formula.

The formula is derived by writing general expressions for areas of end and middle sections of three level work, assuming the ground surface warped, substituting these in the prismoidal formula and the mean end areas formula, and subtracting the former from the latter.

For regular five level work an analogous formula gives the corrections for parts of the solid beyond the edges of the road bed, and the remainder does not need correction.

If it is desired to apply the correction to irregular work, it must be done approximately by using transformed sections.

8. Mean End Areas with Gillette's Correction. $C = D\ L\ (B-b)$ where C = correction to be subtracted.

B = larger end area.
b = smaller end area.
L = length.

D = a coefficient depending on the value of $\frac{B}{b}$ and given in the following table:

$\frac{B}{b}$ =	1	1.2	1.6	2	3	4	6	8	10
D =	.0000	.0003	.0007	.0011	.0017	.0021	.0026	.0029	.0032
$\frac{B}{b}$ =	15	20	30	60	100	500	1000	10000	Inf.
D =	.0034	.0039	.0043	.0048	.0051	.0056	.0058	.0061	.0062

This method was published by H. P. Gillette a few weeks ago (*Engineering News*, Dec. 13, 1900). It applies to pyramids and frustums of the same.

The derivation is similar to that of the prismoidal correction. The volume of a frustum by the rigorous formula is subtracted from the volume as found by the mean end areas formula to get the correction.

9. Middle Area Formula. $V = \frac{L\ M}{27}$. Same notation as before.

This is equivalent to considering the mid-section as extending the whole length of the solid.

10. Middle Area with Prismoidal Correction. Correction, $C = \frac{L}{24 \times 27} (c - c_1) [(d + d') - (d_1 + d_1')]$

This is just one half the prismoidal correction for mean end areas formula, but has to be added instead of subtracted.

11. Frustum Formula. $V = \frac{L}{3 \times 27} (A_0 + A_1 + \sqrt{A_0 A_1})$ Same notation as before.

This assumes that all surface lines intersect if produced in a common point. No simple expression can be derived as a correction formula.

12. Equivalent Level Sections Method. This consists in finding level end sections of the same areas as the actual ends, then computing the volume by any of the preceding methods, especially the prismoidal formula. As, for given road bed and slope the area of a level section is a function of the center height only, the equivalent center height can be found in terms of area of the section by the following formula: $C_L = -\frac{b}{2s} + \sqrt{\frac{A}{s} + \frac{b^2}{4s^2}}$ where C_L = equivalent center height.

With equivalent depths inserted, the prismoidal formula becomes $V = \frac{L}{6 \times 27} [2 s c^2 + (3b + 2 s c_1) (c + c_1)]$. The surface is assumed warped.

13. Tables. Tables and diagrams do not constitute distinct methods, but are devices for applying methods already described.

In Searles' Field Book for Engineers is a table of trapezoidal prisms, 100 ft. long, for various bases and slopes, in which the center height is the argument. It can be used directly for level sections, and for others by first finding equivalent center heights. To get volume by prismoidal formula, the table is entered three times; mean area volume requires two entries and middle area volume one entry.

Tables to give volumes by mean end areas have been prepared in different forms.

Allen gives a form for three level work that uses only center height as argument. But two quantities have to be taken out opposite each height, and some small operations of addition, subtraction and multiplication performed. With these tables are others giving prismoidal correction. These latter are entered with difference of center heights and difference of extreme widths as arguments.

Tables of triangular prisms have been prepared in several forms by Crandall, Allen, Hudson, Johnson, and others. These can be used for three level work by increasing the center heights to include the grade prism. They can be used for irregular work by dividing the cross sections into triangles, and entering the table for each triangle separately. This form of tables can be used to give prismoidal volumes by entering the tables three times for each triangle. Dimensions are used as arguments and not areas.

Tables using areas as arguments are prepared, which, of course, save only the labor of multiplying by $\frac{100}{54}$.

14. Diagrams. The condition that limits the application of diagrams is the same as for tables, viz: there can be no more than two arguments. Accordingly we find diagrams made for about the same cases as tables.

Wellington's Diagrams are the most extensive and complete of any the writer has seen. Among them is one based on Henck's formula, which is not naturally adapted to diagraming.

Taylor in "Prismoidal Formulæ and Earthwork" shows very clearly how to make *one* diagram which will give mean and areas volume, prismoidal volume and prismoidal correction without confusion. The grade prism is included and the diagram is independent of the slope ratio. A separate, very small diagram gives the grade prism to be deducted.

Trautwine combines the use of tables and diagrams. He has extensive tables of level cuttings and with each a diagram for giving the equivalent level height of a section. These diagrams, however, use the transverse slope of the surface in degrees as argument. If the transverse slope was not obtained in the field,

but the ordinary cross-section notes were taken, the cross-sections are to be plotted on special paper, then reduced, if necessary, to two level sections and the transverse slope read off. The table is then used to give the volume.

C. Discussion of Methods.

15. In order to compare the different methods, ten solids were computed by as many different methods as necessary. These were taken from the field notes of a practice survey and not selected. The portions in excavation are consecutive, and so are the portions in embankment.

Of course the exact methods, based on same assumptions about the surface of ground, gave like results, and only such part of the results is presented here as is needed for the comparison.

In column 2 of the table the surface lines are not printed, but they run as follows: In the solids between stations 0 and 1, 2 and 2 + 37, 3 and 3 + 54, 3 + 54 and 4, 7 and 8, the lines diverge from the center on first cross section to the sides on the second. In all the others they run from right side and center on the first to center and left side respectively on the second. Read from bottom of table up.

Station.	Cross-Section Notes.			Areas of Cross-Sections, Surface Warped.	Middle Areas Surface, 4 Planes.	Volume by Pris. For. Surface Warped.	Per ct. Variation in Volume Surface 4 Planes.	Per ct. Variation in Volume, Equiv. Level Sec.	Per ct. Variation in Volume, Mean End Areas.	Per ct. Variation in Volume, Middle Areas.
	18.4		16.7							
11				154.0						
	+5.6	+5.9	+4.5							
				201.2	202.4	748	+0.4	0	+0.6	—0.4
	22.0		21.2							
10				252.5						
	+8.0	+8.1	+7.5							
				264.8	270.0	981	+1.2	0	+0.2	0
	21.2		23.5							
9				277.0						
	+7.5	+8.7	+9.0							
				232.2	237.4	862	+1.5	—0.9	+0.6	—0.2
	17.3		21.8							
8				191.0						
	+4.9	+6.5	+7.9							
				152.8	154.1	569	+0.5	+0.2	+0.9	—0.5
	16.3		16.7							
7				119.4						
	+4.2	+4.6	+4.5							
	19.5		30.3							
4				374.7						
	—9.0	—12.0	—16.2							
				388.5	386.1	663	—0.5	0	0	—0.1
	20.4		31.8							
+54				404.0						
	—9.6	—12.4	—17.2							
				369.6	379.3	740	+1.8	0	+0.3	—0.1
	19.3		26.5							
3				338.0						
	—8.9	—11.8	—13.7							
				319.7	323.5	746	+0.8	+0.1	+0.1	0
	18 1		26.5							
+37				301.8						
	—8.1	—10.6	—13.7							
				277.1	275.5	381	—0.5	—0.5	0	—0.3
	16.9		24.6							
2				254.1						
	—7.3	—9.4	—12.4							
				181.6	178.1	681	—1.3	—0.4	+2.0	—1.3
	13.4		16.9							
1				121.4						
	—4.9	—5.6	—7.3							
				79.3	79.3	298	0	0	+3.3	—1.7
	9.9		10.9							
0				44.7						
	—2.6	—2.6	—3.3							

16. Points of Comparison. Methods are to be compared on the scores of accuracy, facility of application and reasonableness of fundamental assumptions.

17. Prismoidal Formula. The accuracy is unquestioned. It is not easy to apply because of the tediousness of computing mid-sections. This task is much greater when the surface is treated as four plane triangles than when it is two warped surfaces.

18 Henck's Formula. This is accurate for the case to which it applies, and it is easily applied, more so than the length of the formula would lead one to think. For irregular instead of three level work, the labor is greatly increased.

19. Davis' Formula. This is accurate and more easily applied than Henck's—slightly so on three level work and more so on irregular work.

20. Assumptions of Plane and Warped Surfaces. Neither assumption is quite correct. Under both it is expected that straight lines between center stakes, those between side stakes, and those between center and side stakes, will fit the ground. This condition is not attained, however, in the most conscientious cross-sectioning. Neither is the work executed with mathematical precision. So then, none of the sides of the prismoid except the ends have the exact form assigned to them, and there is therefore no sense in splitting hairs about the character of the ground surfaces. When pronounced ridges or hollows run obliquely across the center line, the diagonal method is plainly the better way. In many cases the surface may appear as like to one plane as to either of the other cases. A warped surface is assumed as a general working principle. The diagonal method calls for observation of each solid in the field. The latter is therefore more scientific and more likely to agree with the facts. The amount of variation between the two assumptions appears from the table. It varies both in amount and sign.

21. Mean End Areas Formula. The error of this method in the ten solids considered varies from 0% to 3.3%, and averages about 0.8%. The error may rarely be negative. This occurs when the greater center depth is at same end as the less width between slope stakes.

Wellington is sure that the error in one solid can seldom be as great as 5%, and on a whole line of railroad cannot exceed 1%. These few computations point the same way. Many engineers consider such accuracy sufficient for all purposes. The accuracy is greatest where the end areas are nearest equal. This suggests taking cross-sections close enough together to secure any degree of accuracy desired. This can be done roughly by seeing that the center heights do not differ by more than a certain amount. In the ten solids computed, the one having greatest error had a difference of center height of 3 ft.

Accuracy can also be secured by applying a correction as dis-

cussed below. This can be done so easily that it is hardly advisable to increase the labor of the cross-section party in the field for the sake of saving a little time of *one* man in the office.

The method of mean end areas is easily used, but hardly more so than that of Davis.

22. Mean End Areas with Prismoidal Correction. The correction is easily computed and applied and renders the result correct. In these ten solids all results were within a cu. yd. of the result by prismoidal formula.

The convenience of the method is that the correction need not be applied at first, but at any convenient time before the final estimate is needed.

From the formula for correction it appears that if two center heights are equal, or if distances between slope stakes at two ends are equal, the correction is zero. If either of these is very small, the correction may be neglected.

23. Mean End Areas with Gillette's Correction. This correction is sufficiently exact, as shown by comparisons given by Gillette in his article in *Engineering News*. It was not applied to these ten solids. It has, however, the disadvantage of increasing the labor of computing the end areas, for areas of side triangles are needed besides the areas of the whole sections. The formula itself does not show when the correction is to be added, as is sometimes necessary.

24. Middle Area Formula. The error of this method, as shown above, is one half as great as that of mean end areas, but of the opposite sign. The results in the table agree substantially with this statement. The contractor would therefore not favor its use without a correction. For one solid only one cross-section has to be computed instead of two, but for a consecutive series this advantage disappears.

25. Middle Area with Prismoidal Correction. The same remarks apply to this method as to the method of mean end areas with prismoidal correction.

26. Frustum Method. For this method to be exact all lateral edges of the prismoid must intersect at a common point. As the edges of the roadbed are parallel, this condition can never be fulfilled exactly and seldom approximately. Often the side lines would intersect the center line, if at all, at points beyond opposite ends of the prismoid.

The method is less easily used than the mean end areas method, and does not have the advantage of a simple correction formula as does that method.

27. Equivalent Level Sections. Wellington has shown analytically that this method always gives results too small, unless the surface is a plane. The ten comparisons here made do not contradict his statement. In five cases the method gave exact

results, and among the other five the greatest variation was less than one %. The zero variations and the two plus variations are so small that they may be accounted for in the handling of decimals.

The method is less rapid than that of mean end areas if everything is done by computation. If Trautwine's combination of diagrams and tables be used, the method is quite rapid.

28. Tables. The accuracy of tables depends, of course, on the formula on which they are based and the care with which they are computed. Results can be got more rapidly than by calculations.

29. Diagrams. The accuracy of diagrams depends on the formula on which they are based, the care with which they are drawn and the selection of a scale that makes the diagram easily read. In these days no apology need be made for the use of the graphical method. It finds acceptance in all the departments of engineering as a legitimate, convenient and accurate method. It is more rapid in general than the use of tables.

D. Conclusions.

30. From the ten examples here computed, and from others given by the various writers in illustration of their methods, the following conclusions are derived:

(*a*) Tables and diagrams should be used whenever possible, whether seeking a result by an approximate formula or by an exact one.

(*b*) The methods of mean end areas, equivalent level sections and middle area, are satisfactory for approximate estimates, and often for final estimates. Most of the tables and diagrams are based on the first of these, but the same can be used easily with middle areas.

By applying a correction, exact results can be obtained. Even then the time required is less than is required for getting prismoidal volume from tables or diagrams.

(*c*) The three foregoing methods and the prismoidal formula as ordinarily applied, all treat the ground surface as warped. In the majority of cases this probably leads to no error greater than errors due to imperfect construction. The error, if any, is not cumulative. The surface lines should, however, be drawn in the cross-section book, and used in computation by Davis' or Henck's formula when necessary. This should be done especially when unit prices are high, as in rock work, also when ridges or valleys cross the center line obliquely.

PUBLIC HIGHWAYS.

BY SAM. HUSTON.

The subject alloted me may be considered under five heads: Location, including grades, Drainage, Foundation, Surface, Maintenance.

The above division applies with equal force to any kind of road or pavement, be it macadam, brick, asphalt, or granite block, but my paper, with the implication in a measure conveyed by the title, will have in mind the broken stone road, applicable because of its moderate initial cost, to the common rural way, as distinguished from the street.

Each one of the above divisions could well take up all the time available for my topic, without in any way being diffusive, and, whilst I feel disposed to give some of my experience in building over one hundred and thirty miles of improved road, I am inclined to consider, in a special way, the first division of the subject. Like every other branch of Civil Engineering, each problem is, in some measure, unique. My experience in Jefferson County, where we have valleys one-half mile wide and over two hundred feet deep, natural slopes of one to one, and even perpendicular faces of rock to contend with, would, of necessity, have very little in common with a road builder in Williams or Paulding counties. The intercalated clays, shales, sandstones, and limestones of Jefferson County, predetermine entirely different problems for solution from those presented in a region of gravel terraces or prairie soils.

I desire to refer to the need of education along the line of the fundamental principles of road building, for the reason that the residents and taxpayers of the vicinity are the arbiters and the controlling agency in the location and construction of public highways. Under a form of government like ours, the majority rule, and no one person nor any number of persons, whilst in the minority, no difference how well informed and trained they may be in the line of road building, can build or cause to be built standard or high-grade roads, unless the majority of the taxpayers, who must furnish the means necessary, are convinced that such roads will pay or accrue to their benefit. Along this line of education is great need of effort by State and National commissions and offices of inquiry to elucidate the principles of road building.

In our county there has never, in any case, been sufficient time and care taken in the selection of routes; in fact, no time has ever been permitted for any preliminary surveys, so essential to correct location. In one system of improved roads in our county, consisting of seventy-eight miles, distributed over five townships, the special law under which the roads were built provided that "the

County Commissioners shall appoint three disinterested freeholders of the county as Road Commissioners [no practical knowledge of road building required] and said Road Commissioners shall lay out, survey, and locate such turnpike roads on the present established highways, where practicable."

In practice, the word practicable was used or interpreted in the limited sense of possible, considering therewith only the limitations in Ohio laws as to grades, which, in specifying in Section 4759, in reference to free turnpikes, given seven degrees as a permissible grade, which never, under any than the most exceptional circumstances, should be adopted for an improved road; and in Section 3477, referring to toll pikes, five degrees are made the maximum, which grade, under ordinary circumstances, should be the ultimate limit, and only permissible in extreme cases.

I found these two grades seven degrees; that is, twelve and one-quarter per cent., and five degrees or eight and three-quarters per cent., so impressed upon the minds of county and road commissioners by the fact of being incorporated in the general laws of the State, that when I had answered in the affirmative the query, could the former be secured on an old location, that location was accepted as practicable; and if the latter could be secured, there was no need of time nor expense being devoted to securing a better grade. In one case, of an assessment turnpike, the turnpike commissioners came to view the question of grade in a better light, and adopted a maximum grade of six per cent., and when the contractor began work on the steepest point in the old road, residents actually asked him if he was going to carry the water the other way. Some engineers before me may think the above an exaggeration, but if you saw some of the country roads in the river counties, portions of the same having grades of from twenty to twenty-five per cent., you would, perhaps, better appreciate the conditions to which I refer.

With road locations as we find them, there is given little chance for commendation. Originally, the roads were generally located with an extremely heavy grade up a point and then along a ridge, because they were more easily and cheaply constructed than one carried on an even grade along the slope of the hill. With these most faulty locations as a basis was developed the curious examples of road engineering found almost universally in a hilly or rolling country. Sometimes a change was made that much improved the conditions, but, in many cases, a good dinner by an interested party led a set of road viewers to place a road alteration on heavier grade to accommodate their host, who desired the public highway to be located, not with reference to public interests, but to his own convenience, growing out of the position of his buildings, or, perhaps, the shape of his fields. I call to mind one prominent road in our county, now macadamized, that, some years prior

to its improvement, had been so changed by viewers on petition of a landowner, backed by eleven neighbors, who could not say no, so as to pass his buildings, but increased the distance of travel and greatly increased the grade. Such were the conditions when we came to improve the road, that the defective location was adopted for the improvement, to the inconvenience of the public, and this inconvenience will continue until the public shall demand and secure the correction of such defective location.

Since the improvement of our roads was commenced in a general way, eleven years ago, there has been a great education of the people in the line of road building, especially of location, and I am fully convinced that in the near future our people will demand and secure better location, construction, and maintenance. What is needed is to awaken the people to the advantages of good roads by samples of model roads, or if model roads cannot be gotten, then such samples as may be attainable. For whatever is done along that line will bring fruitage in demand for better service.

A community accustomed to traveling over roads with grades of ten to fifteen per cent., which has as an object lesson the substitution of five or six degree grades, will, in time, not be satisfied until all their grades are improved, and the improvement will continue as the people are educated more and more in the same line. A community accustomed to roads, virtually swales and undrained, given illustrations of what drainage and elevation of the road above the general dead level of surface will do, will not be satisfied until the surface is improved in the most feasible plan attainable at moderate cost, and that improvement will not likely stop with graveling and macadamizing, but will soon demand paving or whatever, in the development of road building in the future, shall be the method of building roads of higher and higher standard.

I believe that the State of Ohio should strike from its statutes, if possible, the implied sanction of the idea that a road of five to seven degrees is a practicable road on which to place macadam. It might be well to have a State commission, that would have the right to reject or annul any new road or alteration that did not accord with the principles of good road engineering.

The annual report of the State Commissioner of Public Roads of New Jersey for 1899, indicates an apparent effort to bring the grade of all its improved roads within the limits of seven per cent., although one reference indicates a road (Watching) with a maximum grade after improvement of over twelve per cent. Nothing is said of the conditions that led the Commissioner of Roads of New Jersey to adopt such a grade, but, judging by the good work on the roads of that State, the conditions connected with the case must have been indeed exceptional. The report of the Massachusetts Highway Commission for 1899 gives a maximum grade of six and one-half per cent. The report of the State Engineer of

New York for the year 1899 gives five per cent. as the maximum on projected roads. European practice, adopting from five to seven per cent. as maximum grades, together with the above States standing in the forefront of road improvement in our own country, indicate what is the result of the experience of the best road builders of the day.

On heavy grades, the action of horses' feet in drawing loads is very detrimental to the surface of broken stone roads by breaking the bond and disturbing the solidity of the surface. The action of wheels locked to resist the effect of gravity on loaded vehicles is almost equally detrimental, and of nearly equivalent destructive action is the effect of dashing rains on heavy grades, in its wearing effect, and especially through the removal of the binder material, which constitutes such an essential element in the surface of our best broken stone roads. The erroneous impression prevails that the only objection to a heavy grade is the difference in the expenditure of motive or horse-power in the hauling of loads. While this is the paramount objection, yet it should not be forgotten that a very essential element is the cost of maintenance, which, in time, and, in fact, a much shorter time than is generally conceived by the casual observer, will equal and exceed the cost of construction of the road upon an easier grade and better location.

Lest some one should infer that this question of elimination of grade has no limit, I would say that, while there is an important and essential question for determination in maximum grade, there is also one of almost equal importance in minimum grade. A dead level broken stone road is very hard to maintain, because surface drainage is very imperfect. Experience proves that about one per cent. is a proper minimum grade.

A large portion of my time has been occupied on the subject of grade alone, which is only one element in the location of roads, forming only one of the five divisions of highway construction, as outlined in the beginning of my paper, and it may appear that I have dwelt at undue length on this one point. I have but this excuse to offer, that I consider it the fundamental and precedent element to all others included in the topic of highway construction. The tendency with most interested persons who have had no practical experience is to consider the question of surface as the one of vastly major importance of the five divisions of the subject, and ignore the element of grade almost entirely. I have found many persons wakened up to the need of improved roads who had no conception of the need of anything but placing the macadamizing material on the old road surface.

My intention, in this paper, shall have been accomplished if I have raised the question of the importance of eliminating from Ohio statutes the implied sanction of impracticable, unscientific,

and erroneous grades; and if I have brought to the attention of any of our members, who may in the future have their first experience in highway construction, the need of considering a question of earlier and more commanding importance than that merely of the surface of the road, they shall be called upon to take charge. The improving of the surface of a road without first remedying its defects of location, grade, drainage, and foundation, but places a barrier in the way of ultimately constructing a road of high standard.

My treatment of the remaining divisions of the subject must be brief and in the nature of a summary. Drainage should be secured by proper crown of about one in twenty-four, to carry the water falling on the surface to the side drains, which should be of sufficient depth to freely and promptly provide removal of rainfall or ground water, and should extend below the level of the foundation. In the event of springs or wet subsoil, underdrains may be used, either under or at the sides of the macadamized surface.

Foundation, consisting of firm clay, well drained and thoroughly compacted by rolling, is sufficient in most cases.

The question of surface for rural ways of any importance seems, for the present, to be, in a measure, confined to macadamizing the same with the best material attainable—trap, if it is to be had. That not being available in Jefferson County, we are compelled to use coal measure limestone of very good cementing quality, but too soft and too easily abraded to form a durable road. It should be broken to a two and one-half-inch ring, thoroughly compacted by rolling, with sufficient, and only sufficient, binder to form a solid bed and a smooth surface. Where fire-brick are cheap, they are attracting the attention of the builders of rural ways, and have been used in quite a number of localities, although not with the most satisfactory results. On something over a mile of assessment turnpike now graded, we propose to use a fire-brick surface, with a fire-clay curb, in the early spring, and I may be able, one year from now, at our yearly convention, to give you some observations of interest in that line of work.

In maintaining a road, one element so often neglected is that of drainage. Ditches will fill up in places, and must be kept in good condition, and of full depth, or a first-class road can never be maintained. The plan of constant and prompt attention is, by all means, the best method of maintenance. As there is some difference of opinion on that point, probably arising from differing conditions, if the method of repair is adopted; that is, allowing the surface to take care of itself for a time, then making considerable addition of material to the whole surface of the macadam, then let the material be spread and thoroughly rolled when moist or wet; and when the tendency to rut appears, which is inevitable for a

time, it should be remedied by raking, or by the addition of more material.

The last fact to be kept prominently in mind, as to maintenance, is that no macadam road can be kept in good condition over which pass heavily loaded vehicles with narrow tires.

1900

SPECIFICATIONS

For the Construction of the Empire Free Turnpike, Jefferson County, Ohio.

SECTIONS.

The work herein specified is divided into the following sections:

SECTION 1. Begins at the initial stake, near Freeman's upper works, and ends at the C. & P. R. R., in Empire; length, 5,650 feet.

SECTION 2. Begins at the C. & P. R. R., thence along the Sugar Grove road to station 95, on lands of F. and L. Henstock; length, 3,750 feet.

SECTION 3. Begins at the end of Section 2, thence to the three-mile post, near Sugar Grove school house; length, 6,340 feet.

SECTION 4. Begins at the end of Section 3, thence along the Knoxville road to the residence of Chalmers Culp; length, 5,895 feet.

BIDS.

Persons bidding for the work shall do so on the blank form hereunto attached, and each bid must be for all work required on each Section, as no Section will be let in two or more contracts.

EXCAVATION.

All grading will be measured in excavation, and will be divided by the Engineer into three classes: First—Earth, consisting of clay, loam, gravel, and loose stone. Second—Shell rock, material that can be loosened by the pick. Third—Solid rock, material requiring blasting. Each class shall be bid and paid for by the cubic yard, to be used in fills or spoil banks, as directed by the Engineer. Slopes may be changed by the Engineer if material is found to require it. Moving material more than 100 feet horizontal to be bid and paid for by the cubic yard, for each 100 feet in excess of 100.

GRUBBING.

Nothing will be allowed for removing trees less than 6 inches in diameter, at 18 inches from the ground. Removing larger ones to be bid and paid for by the tree.

DRAINS.

Sewer pipe drains or culverts shall be laid as directed, shall be of 12-inch shouldered, hard-burned pipe, of good quality, to be bid

and paid for by the linear foot. Those marked on profile are not in contract, but will be put in by the county.

SIDE DRAINS.

Side drains shall be constructed of such depth and width as directed by the Engineer, and work will be classed and included with excavation.

ROAD BED.

One line of pegs will be set by the Engineer, by which the road bed shall be constructed, of such width as directed, so that the macadamizing material shall be held in place by wings of earth, and shall have a crown of 1 in 24. Preparation of road bed shall be bid and paid for by square rod of road bed and wings, and the estimate shall include the entire length of road.

MACADAM.

The macadamizing material shall average 12 inches deep when completed for acceptance, and 10 feet wide. Six inches thereof shall be of limestone of good quality, not liable to disintegrate by frost, knapped or crushed to pass through a three-inch ring. The remaining six inches to be of limestone of good quality as above, knapped or crushed so as to pass through a two and one-half inch ring. If crushed stone is used, not more than one-fifth nor less than one-eighth of the material used, consisting of the dust or fine portions of the same, shall be screened from both layers, and be evenly spread over the surface of the upper layer before rolling the same. Each layer shall be thoroughly rolled to a firm bedding. The roller shall have a weight of at least six tons, and shall be passed over each part of each layer from eight to twelve times at the option of the Pike Commissioners.

The limestone used shall be of good quality, free from anything that shall cause it to moulder through the action of the weather, and the admixture of any condemned stone shall subject the contract price to such discount as the Engineer shall judge the road injured thereby. No macadam shall be placed on fills of over two feet in depth before May 1, 1901.

GENERAL.

Any part of the work may be dispensed with at the option of the Pike Commissioners.

During the progress of the work, it shall be open to inspection by the Pike Commissioners and the Engineer.

Public travel shall not be delayed by any unnecessary obstruction of the road.

The work on each section shall be completed on or before September 1st, 1901, and all grading shall be completed on or before January 1st, 1901.

All work to be done in a workmanlike manner, and the Con-

tractor shall be responsible for any or all avoidable injury to person or property. The work to be at the Contractor's risk until final acceptance; who shall not transfer or sublet any part thereof, without consent of Pike Commissioners, signified by resolution, who shall have the right to designate what part of the work shall be first done.

Monthly payments, to the amount of 85 per cent. of Engineer's estimates, shall be made on the third Monday of each month, and non-completion of the work within the specified time shall forfeit the remaining 15 per cent. of estimates.

Whenever a section is completed, the same shall be inspected by the Commissioners, in company with the Engineer, and if the work is completed to their satisfaction, then they shall issue a certificate of the amount of work done, and the Contractor shall receive pay in full on said work so inspected. No advancements nor other payments will be made except as specified above.

BOND

Before the contract is fully awarded, the successful bidder or bidders shall file an approved bond to the amount of $2,000 for each section included in their respective contracts, conditioned upon their completion in accordance with the specifications.

Before any bid shall be opened or considered by the Commissioners, the respective bidders shall deposit with the Treasurer of the Empire Turnpike, cash or a certified check to the amount of $300 on each section included in their bid, which shall be forfeited by the bidder to the Empire Free Turnpike Fund, in case bidder fails to enter into bond and contract within five days of notice of acceptance of bid.

Bids will be received for constructing Section 1 of brick, as well as of limestone, and the Pike Commissioners reserve the right to award said section to bidders on macadam or brick, irrespective of total amount of cost.

SAM HUSTON, *Engineer.*

BID.

To the Commissioners of Empire Free Turnpike:

Sirs...... ....will do the work as set forth in the foregoing specifications on Section No. .....at the following prices:

Excavation, earth, per cubic yard, - -	....	cents.
Excavation, shell rock, per cubic yard, - -	....	"
Excavation, solid rock, per cubic yard, -	....	"
Overhaul, per cubic yard, per 100 feet, - -	....	"
Grubbing, per tree, - - - - - -	....	"
Sewer pipe laid, 12 inch, per linael foot, - -	....	"
Preparing road bed, per square rod, - -	....	"
Macadamizing, per cubic yard, - - -	....	"

(Signed).................... ....Contractor.

CONTRACT.

It is hereby agreed, by and between ...., party of the first part, and the Commissioners of the Empire free Turnpike, Jefferson County, Ohio, party of the second part:

The said party of the first part, agrees to do and perform, for and in consideration of the covenants of the party of the second part hereinafter mentioned, the work on Section No. .... of above described roads, at the prices in the above proposal, according to the specifications hereto attached and to plans and profiles on file at the residence of Frank Stone, all of which are made a part of this contract.

And the Board of Commissioners, party of the second part, for and in consideration of said covenants and agreements of the party of the first part, agree to pay said party of the first part for said work at the stated rate in said proposal; said payment to be made for said section, upon its completion to the satisfaction of the Commissioners and the Engineer. This contract to take effect and be in force when signed by the Commissioners of the said Free Turnpike.

In Testimony Whereof, the parties of the first and second parts have hereunto subscribed their names this .... day of ...., 1900.

....

....

....

Commissioners of the Empire Free Turnpike.

................................*Contractor.*

1900

SPECIFICATIONS

For Paving Section 1 of the Empire Free Turnpike.

The work herein specified begins at the initial stake of the survey of said Free Turnpike near Freeman's upper works, and extends thence northward along the Steubenville and Wellsville State road to Stewart street in Empire, thence with said street to the C. & P. R. R.; length, 5,650 feet.

BIDS.

Persons bidding for the work shall do so on the blank form hereto attached, and each bid shall be for all the work required, as it will not be let in two or more contracts.

EXCAVATION.

As excavation will be classed, all work in bringing the surface to proper grade and cross section, excavating trenches, ditches, and road bed will be measured in excavation, and be bid and paid for by the cubic yard without classification. Shall be used in fills

and spoil banks as directed by the Engineer. Slopes may be changed by the Engineer. Moving material more than 100 feet horizontal to be bid and paid for by the cubic yard for each 100 feet in excess of 100. No spongy soil or vegetable matter shall be placed in embankments except as directed.

TREES.

Underbrush, stumps, and all other obstructions shall be removed by the Contractor, and no extra allowance shall be paid for the same except that trees six inches or more in diameter at eighteen inches from the ground shall be bid and paid for by the tree.

SIDE DRAINS.

Side drains shall be constructed of such depth and width as directed by the Engineer, and such work shall be classed and included in excavation.

SEWERS.

Four-inch sewer pipe drains, length of joints two feet, shall be laid true to grade in the trenches at sides of paving as indicated on cross section sheet, and will be practically continuous on each side of the pavement. Twelve-inch sewer pipe shall be laid as directed by the Engineer for approaches to the improved road. The sewer pipe and stone culverts marked on the profile are not in contract but will be contracted and paid for by the County Commissioners. All sewer pipes shall be shouldered, hard burned, glazed fire clay pipe of good quality. Fire cracks or slight deformations that do not affect strength or capacity will be allowable, but pipe otherwise defective must not be delivered along the road.

FOUNDATION.

Foundation material shall consist of limestone of approved quality, or broken vitrified sewer pipe, either of which shall be broken to pass through a two and a half-inch ring, with sufficient finer material to fill voids after rolling, and prevent sand cushion from passing downward. Such material shall be placed in the trenches, over the four-inch pipe and around the same up to within eighteen inches of the surface of the sides of the completed pavement, and together with the sub-grade, shall be thoroughly rammed, or rolled with a roller weighing or weighted to eight tons. Said work being done when the sub-grade is in a moist condition, and care shall be used that the sewer pipe are not injured, crushed, or displaced.

CURBING.

Curbing of quality and manufacture the same as Ohio River paving brick, eighteen inches high, three inches wide on top, and seven inches wide at the base, and not less than two feet long, and of the form indicated on cross section sheet, or of sandstone eighteen inches high, five inches wide on top, and not less than six

inches wide at base, and not less than thirty inches long. The stone to be hard, durable, and acceptable to the Pike Commissioners and Engineer, top to be dressed off square to side next pavement, which side shall be dressed down six inches to give even and full bearing to end of brick. End joints to be dressed at right angles to fit close to full depth. Bidders shall state kind of curbing they will use, and the Pike Commissioners reserve the right to award as between the kind of curbing without reference to estimated cost of the work.

Curbing shall be placed and solidly bedded on the foundation as designated above, so as to stand true and even to grade and line. Curbing shall be bid and paid for by the linear foot of the same.

In the trenches partially filled as above and upon the sub-grade shall be placed layers of not more than six inches in depth of above specified foundation material, each layer of which shall be rolled or rammed to the satisfaction of the Engineer. The surface of such material when complete and rolled, shall fill the trenches outside of curbing to the level indicated on the cross section sheet as surface of completed road, and between the curbing to within four and one-half inches of the same, with smooth and even surface, with same curvature as completed pavement. Between the curbing and upon the foundation thus prepared and thoroughly compacted, a layer of clean, dry sand shall be placed, and shaped to the form shown on cross section sheet by a templet scraper, with a depth of one-half inch. The above with the sand cushion shall be classed as foundation, and be bid and paid for by the cubic yard, measured when the road is complete.

PAVING.

Upon the sand cushion the brick paving shall be laid. The brick shall be of standard size of the best quality, or sound, tough, Ohio River fire clay paving brick, hard burned, of good shape, free from flaws, cracks, or breaks. No bats shall be used except at curbs, where half bricks shall be used to break joints. The Engineer may subject samples, selected by himself, to any reasonable tests as to durability and fitness. Bricks shall be subject to any inspection designated by the Engineer, both before and after laying, and all rejected brick shall be immediately removed from the work, and not returned to it, and the deficiency made good by the Contractor.

The brick shall be laid on the sand cushion, on edge, at right angles to center line of paving, and be kept in even, straight lines; with all joints broken at least three inches, and in perfectly upright position, the brick to fit close on ends and sides. In making closure at curbs, care shall be taken in shaping and trimming not to check or fracture the bricks, which shall be broken or cut at right angles to their tops and sides, and the work shall be done by experienced men.

The brick shall then be covered with fine dry sand to be well

broomed in, sufficient only to fill the interstices or joints. When laid as above, the brick shall be thoroughly rolled with a roller of five tons weight, and any portions of the pavement, that in the judgment of the Engineer may require the same, shall be rammed to his satisfaction, either before or after rolling, a plank being used under the rammers. After rolling, the surface of the paving shall be true and even to the grade and cross section, must show no continuous lines, or unequal settlement, and the Contractor shall remedy any such deficiencies. When complete as above, the surface of paving shall be evenly covered with one-half inch of clean, dry sand.

GENERAL.

No extras will be allowed, and work and materials required shall be provided by the Contractor. All the work shall be done in a workmanlike manner to the satisfaction of the Engineer and under his direction.

Any part of the work may be dispensed with at the option of the Pike Commissioners.

During the progress of the work, it shall be open to inspection by the Pike Commissioners and the Engineer.

Public travel shall not be delayed by any unnecessary obstruction of the road.

Grading shall be completed on or before January 1st, 1901, and no paving shall be laid on fills of more than eighteen inches before May 1st, 1901.

The entire work shall be completed on or before September 1st, 1901.

The Contractor shall be responsible for any and all avoidable injury to persons or property. The work to be at the Contractor's risk until final acceptance; who shall not transfer or sublet any part thereof, without consent of Pike Commissioners, signified by resolution, and the Pike Commissioners shall have the right to designate what part of the work shall be first done.

Monthly payments, to the amount of 85 per cent. of Engineer's estimates, shall be made on the third Monday of each month, and non-completion of the work within the specified time shall forfeit the remaining 15 per cent. of estimates.

When the work is completed, the same will be inspected by the Commissioners, in company with the Engineer, and if the work is completed to their satisfaction, then they shall issue a certificate of the amount of work done, and the Contractor shall receive pay in full on said work so inspected. No advancements nor other payments will be made except as specified above.

BOND.

Before the contract is fully awarded, the successful bidder or bidders shall file an approved bond to the amount of $4,000 conditioned upon its completion in accordance with the specifications.

Before any bid shall be opened or considered by the Commissioners, the respective bidders shall deposit with the Treasurer of the Empire Free Turnpike cash or a certified check to the amount of $300, which shall be forfeited by the bidder to the Empire Free Turnpike Fund, in case bidder fails to enter into bond and contract within five days of notice of acceptance of bid.

SAM HUSTON, *Engineer.*

CONTRACT.

It is hereby agreed by and between ...., party of the first part, and the Commissioners of the Empire Free Turnpike, Jefferson County, Ohio, party of the second part:

The said party of the first part, agrees to do and perform, for and in consideration of the covenants of the party of the second part hereinafter mentioned, the work above described, at the prices in the above proposal, according to the specifications hereto attached and to plans and profiles on file at the residence of Frank Stone, all of which are made a part of this contract.

And the Board of Commissioners, party of the second part, for and in consideration of said covenants and agreements of the party of the first part, agree to pay said party of the first part for said work at the rate stated in said proposal; said payment to be made for said work, upon its completion to the satisfaction of the Commissioners and Engineer. This contract to take effect and be in force when signed by the Commissioners of said Free Turnpike.

In Testimony Whereof, the parties of the first and second parts have hereunto subscribed their names this .... day of ...., 1900.

....

....

....

Commissioners of the Empire Free Turnpike.

.................................*Contractor.*

BID.

To the Commissioners of Empire Free Turnpike:

Sirs ....will do the work as set forth in the within specifications at the following prices:

Excavation, per cubic yard,	....	cents.
Overhaul, per cubic yard, per 100 feet,	....	"
Grubbing, per tree,	....	"
Sewer pipe laid, 4 inch, per lineal foot,	....	"
Sewer pipe laid, 12 inch, per lineal foot,	....	"
Foundation, per cubic yard,	....	"
Fire clay curbing, per lineal foot,	....	"
Sandstone curbing, per lineal foot,	....	"
Paving, per square yard,	....	"

(Signed)........................ Contractor.

APPROXIMATE ESTIMATE.

Excavation, 10,000 cubic yards.	**Trees, 20.**
Overhaul, 10,000 cubic yards.	**Foundation, 4,200 cubic yds.**
Four-inch sewer-pipe, 11,000 feet.	**Curbing, 12,000 feet.**
Twelve-inch sewer pipe, 100 feet.	**Paving, 6,200 square yards.**

Mr. Huston: "I don't know whether it will be of any value to the Society, but I will place at the disposal of the members the last specifications prepared for macadamizing the last road in our county, the Empire Free Turnpike. They are not in accordance with my ideas, but as nearly as I could get the Pike Commissioners to adopt."

The Chair: "The paper is open for discussion."

Mr. Niederheiser: "I move that the sets of specifications presented by Mr. Huston be published, in connection with his paper, in the proceedings of this meeting."

Seconded by Professor Brown. Carried.

Mr. Cronley: "Have you done any paving in the county?"

Mr. Huston: "Not outside of the cities. In Toronto, Mingo Junction, and Steubenville, where the heavy loads are passing, we find it impossible to keep the roads in good condition by using macadam, and we have substituted paved streets for those roads wherever possible. Under the laws of Ohio, wherever we can get the corporation through which the road passes to construct curbs and ditches, it is expected to keep up the roads afterwards. So after it is completed it is off the commissioners' hands, and we have a road good for years. We have the best paving brick made. These specifications for paving Section 1 are, in a measure, experimental, but I hope for good results. There is no trouble in making paving a good substitute for macadam if you have the money to spend, but the trouble is the cost of building a wide road to allow passing. We are going to try a narrow road, but hope to have something to report next year, and expect a great deal from this paving."

Professor Brown: "May I ask what sort of foundation you expect to use—gravel?"

Mr. Huston: "The conditions under which we propose to build that mile of paving are exceptional. It is along the Ohio River, and the 1884 flood and every flood for eight or ten years comes over that road and it gets a thorough soaking. The provisions we have made there for foundation and drainage (as will be seen from the specifications) are peculiar, from the fact that it is located right along a sewer pipe works, where they are glad to get rid of their waste. So we will put on broken sewer pipe a foot thick. We can get that material for nothing, and they will go 'halves' for hauling it from the works to the place of putting it on."

Mr. Strawn: "With regard to the method of constructing the brick street paving, in our city we have been putting down a good many miles of brick paving. The first paving was done probably twelve years ago. That paving is in good preservation to-day, and has had no repairs except where it has been cut into for sewer pipe laying, gas pipe laying, making house connections, etc. But within the last few years, perhaps not more than four or five years, they have been using a grout filler, and the contractors have decided that the grout filler is more expensive than brick, and uniformly have taken to pressing the brick into the closest possible connection by crowbars, making a solid mass over the street. The result is, that on driving over these streets a year after they have been put down, you will hear a rumbling noise as if traveling over an arch not resting on the foundations. The sand has settled or the bricks have raised. Of course, we know it is caused by expansion due to the almost solid materials used in the construction, and the bricks in places become so much elevated or the foundation has so much gone down, that when a traction engine or heavy load passes over it, the bricks are unable to stand the weight, and, consequently, the bricks will be crushed in patches, and a howl goes up against the brickmaker for not sending good brick, and another against the contractor for not having a good inspector. Again, we will see in places a streak, as though the lightning had struck the road and torn up almost a direct line for a hundred feet along the axis of the road. I found that Youngstown had the same trouble."

Professor Brown: "Columbus has the same trouble."

Mr. Strawn: "What kind of expansion joint could be put in to obviate that difficulty? Professor Brooks has constructed a magnificent home, costing twenty-five thousand dollars, and has constructed a private street running pretty nearly half a mile through the place. The center is limestone macadam, rolled very thoroughly, which makes a beautiful dry weather drive. On either side is a brick roadway—a regular boulevard. In this brick paving, Mr. Brooks has put expansion joints, which are nothing more nor less than about a seven-eighths strip of soft wood, and he has not had a particle of the trouble we have had on the other streets. He has allowed no heavy hauling over this roadway, but is always pleased to have carriages and such vehicles to travel over it. But he has signs at either end of the driveway: 'Please in wet weather drive on brick.' Every one respects this request, and the center road has been put to no severe test. But in the matter of brick paving for extremely heavy hauling, it seems to me that some provision should be made for a proper expansion joint, and allow the brick to come in contact with the foundation, and not be subject to this crushing strain as when arched.

"I would like to hear the experience of the members in regard to method of constructing brick pavement to avoid this trouble of arching of the surface."

Mr. Bowen: "Inasmuch as I have had a little experience on both ends of the line, as engineer and contractor, I probably would have some right to speak on this subject. There has been a good deal of theory and some buncombe regarding brick paving. A little strip of soft wood is an æsthetic idea, and we might consider what is going to happen when that little strip becomes rotten.

"I raise an objection to filling the interstices between brick with asphalt or coal tar. I also object to filling the joints with cement filling that creates this crown which Mr. Strawn speaks of. If the curbstone which held the roadbed in place had not been quite so strong that thing would not have taken place. The abutments (which is the curb itself) being so strong, kept the arch intact, and when the foundation settled down a little, which it will naturally, a vacuum is created below, and it will certainly break. I have observed that same condition myself, and have seen places broken down by heavy teams passing over, and in driving over such places there is a roar like as if there was a cavern beneath. As I believe, either of these methods is an unnecessary expense to the people who have to pay for the improvement. I have, in my time, I am free to say, (inasmuch as I am human as other men are,) advocated grout filler for brick pavements and at other times advocated coal tar filler, because it seemed apparent that the most of the people wanted it that way—that 's when I was on the other side, looking for a job. (Laughter.)

"But the plainest and best way to make a brick pavement, in my judgment, is to fill with sand. Get sand of the proper grade and fill the interstices with it, and it will answer as well as coal tar or asphalt or cement grout. It is much cheaper. It adds largely to the cost of a pavement to fill with tar or cement either. But the principal thing for a brick pavement is a substantial foundation. That can be best made of concrete. It should not be less than six inches thick and formed exactly with the grade of your finished paving, and then allow an inch, or two inches, if you prefer, of a sand bed on the concrete before the bricks are laid. That makes a complete foundation. The careless method adopted sometimes, even where you have a concrete foundation, of putting it in irregularly, sometimes fully up to the grade, and other times four or five or six inches below grade, on the theory of bringing the whole thing up to a uniform grade with sand, will not do. The pavement will not stand; it will become undulating. Where the sand is thicker the bricks will settle, and where there is little or no sand the bricks will not settle, and it naturally becomes irregular. That is about my experience in the brick paving business. It largely depends on the quality of brick, as to its durability, and very much depends upon the amount of travel brought upon the street. But whether the travel is much or little, there is a right and a wrong way to make the pavement, and that is to consider the cost."

Mr. Strawn: "I will ask Mr. Bowen what crown regulation you use for say a thirty-three-feet roadway?"

Mr. Bowen: "Four or five inches is sufficient. Five inches would be the maximum I would put on."

Mr. Sarver: "At Canton, we are in the center of the block paving manufacturers. They are all around us, and we have been paving quite extensively the last four or five years. We have been using a gravel foundation, well compacted, with a two-inch sand cushion. We have been using a sand filler with grout in the gutters on each side, but we find the cement grout filler is the best. We use two of cement and one of sand—light loam sand for expansion joints. The expansion joints are made in the following manner: As the brick are being laid, we take a common, ordinary building lath and lay them between the brick. We found by just making one joint at each place, the brick, as the tar was expelled by the expansion of the cement setting, the two bricks form an arch and made a rough surface. We make a double joint on both sides, with one layer of brick. After the pavement is all rolled and ready for the filler, we pull out the lath and fill the joints full of asphaltum tar filler. After the joints have been filled, and the tar is cold, then we fill the joints completely full of this grout—two of cement and one of sand, brushing it in two or three times, as required. The tendency is to make more of these expansion joints. But with the gravel foundation and the transverse joints about thirty feet apart, we have eliminated almost entirely these arches.

"The older streets were laid with broken stone foundation and two inches of sand; but the sand goes down between the stone and causes unevenness. We have an excellent gravel, and are not troubled with the sand leaving its proper position.

"The joints in the gutter are made by running four or five layers of brick lengthwise of the street, instead of extending the transverse layers completely to the curb, and I think we are getting pretty close to the proper number and proper construction of the joints. We make the crown five inches, and, after it is tamped, it goes down about half an inch; and in a thirty-feet roadway we get about four and a half inches; and for a forty-feet roadway, five inches. These pavements have only been in five or six months, but seem in good condition.

"We have a street that has been in about fifteen years, with a broken stone foundation and sand filler, and have breaks in it caused entirely by the sand leaving the brick and the consequent arching of the brick. We use a sandstone curb six by twenty—none less than three feet in length, set in six inches of gravel and backed with same amount of gravel. We have a clay soil, but, by using this kind of gravel, the draining is excellent and the curbings on the streets have kept their alignment excellently."

Mr. Kemmler: "There is one serious objection to cement filler

which has not been mentioned yet. All other faults, I think, can be overcome by proper plans and construction. This objection I speak of is the tearing up of the street by longitudinal trenches by the gas companies, etc. There has been no way found yet that I know of by which such a street can be put back in the same condition in which it was before. You can cut a straight trench there, but you cannot get out the brick without cutting off the neighboring brick, and so in replacing the street leave a joint the length of the trench. If any one knows of any way the brick can be put back and properly jointed as it was before, he has a good thing.

"Regarding the objection to the grout filler, the expansion can be avoided to a large extent by paving in season—in summer. If you are paving in winter, or after the temperature gets down towards freezing, the proper thing is to avoid grout filler, and use something else. It is not necessary, as a rule, to do much paving out of season, but where such is the case, it is unwise to use a cement filler and run the chances of having it act as it has done in many cases.

"I have noticed, as one of the phenomena of these grout-filled brick pavements, the lightning-like streaks that Mr. Strawn spoke of; another, that of settling in patches. The long cracks, I think, are due to expansion or contraction. I can't see any other reason for them; but these others are ninety per cent. of them, I think, due to a settlement of the foundation—defective plans of construction.

"Most of ours that have failed (they have all failed), have been mostly on account of the foundation not being constructed properly. They are on a broken stone foundation, with two inches of sand for cushion, and in some places may be three inches of sand. Two inches of sand, in the first place, are too much; and the upper spaces in the broken stone are filled, but not the lower. The stone is all put on in one course of eight inches, and the upper layers filled with sand. When a horse comes along and strikes this pavement, it acts like a sounding board. The sand gets dry and works its way down, so that pretty soon your sand cushion is gone an inch or an inch and a half. This does not occur all over the street, but in patches, wherever there is a weak spot; and therefore those patches go down. There is a space underneath there, and there is not strength enough in the brick to hold up when a steam roller or heavy engine goes over it.

"We can avoid this by a compact foundation, either of concrete or, as used in Canton, a gravel, which is compacted so no material can get into the spaces. Then we have cut down our sand cushion from two to one inch, and are very careful that the surface of our concrete is just about right grade, as nearly right as we can get it, so there is no variation of more than a quarter of an inch, if we can help it. We are careful, after the brick are laid, to ram it very

thoroughly, in order to prevent future settlement in the sand cushion. After we have rammed it thoroughly, if the surface is not as smooth as we would like to have it, we take a roller, four to six tons, (sometimes lighter, but not heavier than six tons,) and roll it thoroughly. After this has been done, if you take up one of these blocks or bricks and try to punch a hole into that sand you will find it almost like rock, and there is very little settlement after that. We can't possibly have any settlement there to cause any of the phenomena spoken of.

"In regard to the sand filler, I have to take exception to the statements of Mr. Bowen. I believe and admit that sand filler is better than any tar filler; but I think the filler is not only for the purpose of preventing water from getting under the pavement and to hold the brick in place, but to protect the edges of the brick at the joints, especially the brittle and soft brick. You find a good many streets in Columbus here where the brick have been brittle, and find a good many where the brick have been tough, especially some of the old West Virginia fire clay brick, twelve or fifteen years old. You will find the brick worn flat—no edges worn off—worn uniformly. That kind of bricks do not need grout or tar filler, just enough sand to fill the joints. They will wear as well that way as with a good grout filler. But the brick manufacturing business is young yet, and no large plant can turn out the same kind of brick right along, even if they have the reputation for making first-class brick—they will get some bad ones occasionally. There is no way to pick them out, no test—not even the rattler test will pick out the bad brick—that is, indicate what proportion of the brick are bad and what proportion are good. So we have got to consider that fault of the brick. If we can find a filler which will stay in the joints and wear down with the brick, and, at the same time, prevent these phenomena of settling and forming of arches, we have got a filler which will increase the life of the brick pavement anywhere from two to five years.

"We have some cases right here in this city—one street running south from Fulton Street to the City Park, on Third Street, where a Hallwood block pavement was laid about eight years ago, and the brick are all rounded off and are wearing off very fast now, wearing off much faster now than in the beginning, as there is more surface there now for the tires and horses' feet to wear on. For that kind of a pavement, I think the grout filler can be made to apply and increase the life of the pavement very much."

The Chair: "I wish to say, in regard to cross trenches, in Warren, Ohio, we had occasion to open up the street just after it had been newly paved, to put in a sewer connection. The work was done by the city at the expense of the property owners. We started out with the intention of making a good job, and dug the trench three feet wide and took off about five feet of brick and concrete

over the trench, about a foot each way. In making our back-fill, the usual practice in city work would be to put on two shovelers and one tamper, but we reversed that and put on one shoveler and two tampers, putting the laziest man we could get on the shovel and the two quickest men on the tampers. We got all the dirt back, and a little extra. Instead of taking out the concrete six inches each side, we took out one foot, and the new portion rested on the shoulder of the trench one foot each side, uniting as well as we could to the original concrete, using one part cement, two parts sand, and four parts broken stone."

Mr. Kemmler: "My objection was, that in cutting a trench longitudinally across the street, you can't get the brick out from betweeen its neighbors, but must cut it off even, making a straight line, and must put it back the same way, making a continuous joint. Regarding back-filling, in franchise work here, we compel them to put four tampers to one shoveler, and we get all the dirt back, too."

The Chair: "The time is passing, and perhaps we had better go to the next paper, 'The Interurban Electric Railway Terminals at Dayton, Ohio,' by R. E. Kline, Dayton."

INTERURBAN ELECTRIC RAILWAY TERMINALS AT DAYTON, OHIO.

BY ROBERT E. KLINE.

One of the problems encountered in cities of modern growth which is now manifested at Dayton is that of obtaining rapid transit or efficiency in the operation of city street railway cars, and a successful handling of passengers and freight in interurban service to the desirable points or terminals in the city.

To attain these ends, as well as to afford a satisfactory service with as little congestion of cars as possible on streets most used by such lines, is the problem. With us, the matter becomes of increasing urgence since the advent of electric power, with attending increase in street and interurban railway operation.

It is usual, in the location of lines, first of all, as much as possible, to follow streets and routes most desirable from the standpoint of securing patronage.

After numerous lines have been so constructed following this idea, as products of different periods of the past, the presence of circumstances conflicting with satisfactory street railway operation is manifest more than ever before cropping out to the dissatisfaction of many impatient passengers, in delays at crossings and by reason of the necessarily frequent stops of long lines of waiting cars, resulting from the fact that too many companies are forced to occupy common tracks to get to and from the center of the city.

It is the natural idea and preference, and usually a first solution to bring all lines to pass, if possible, a single point in a city of the size of Dayton, by the construction of a loop where necessary, over which all linese which terminate therein will be required to pass, and over portions of which it is desired that all city lines must also run.

The points of advantage to be attained by the method are manifest, not taking into account features that are objectionable which arise. Transfer of passengers from one line to another is thereby facilitated. In some instances, a single waiting station is possible. Perhaps even one place of management for each department of street and interurban railway business may be feasible.

There is also another point to be noted. It seems to be desirable on the part of a great number of our enterprising merchants, as is elsewhere wont to be the case usually, to bring all passenger cars as much as possible to pass along or as near as possible to the streets upon which their individual places of business front. Some object as a matter of principle to having additional tracks on any business streets. However, there are a few so inconsistent as to desire this service as near them as possible who, nevertheless, object to the laying of tracks on streets along their own frontage, in case they are now unoccupied by railway tracks.

The establishment of a simple loop is an idea that now prevails in the city of Dayton, over which all cars will be required to pass. It is maintained that this plan will meet the conditions and requirements as they now exist.

No doubt a test of such an arrangement following the prevailing idea of a simple loop, as stated, would not only at this time prove unsatisfactory and impractible, but would later prove exceedingly cumbersome and objectionable to all concerned.

Efforts of certain private individuals are now being put forth in attempts to solve this problem, adopting some such plan, the motive, however, being, in some instances, in addition to the end of facilitating street railway service, with the idea that they be material, to a greater or less extent, in perfecting the deal, perhaps in the disposal of needed property, right of way, or in financing the project.

Any one of the propositions suggested may be in part or entirely right, but let us hope, in the interest of future Greater Dayton, to determine this absolutely before any venture involving any considerable expenditure, be made.

A practice that is now prevalent in the loading of freight, baggage, etc., on cars that stand on the tracks on streets in our city, especially where such tracks are now used by city railway cars of frequent service, must, sooner or later, be abandoned; in fact, it should never be tolerated on any street, except as a temporary expedient.

It is not presumed that this paper will, by any means, finally dispose of every proposition or difficulty; perhaps no more than suggest a few pertinent ideas worthy of consideration, and, to a certain extent, direct the thinking public to some practical solution of the problem. If any suggestion worthy of further consideration may be offered, a willingness to lend any future efforts, if the same may be called for to the end of assistance in securing the proper result named, shall certainly be forthcoming.

A glance at the accompanying map shows the city of Dayton, and the numerous towns of more or less importance located in the same counties within a radius of forty miles, from practically all of which Dayton is now readily accessible by means of the excellent interurban facilities radiating from Dayton to an extent that strikes one as being remarkable. In the construction of all these lines it has been my fortune to render more or less service as engineer. It is a safe assertion that but few cities in the world have attained a service in any degree equal in excellence to that manifest in this particular case. The lines in red on the map indicate those already built or building, while the lines in blue indicate those in process of promotion and likely to be built within a year.

The last map of the city of Dayton shows the location of the city street railway lines connecting practically all sections of the city and radiating from the central and business portions of the same. These have occupied the streets, and there has been heretofore but little interference or annoyance, by reason of the number of cars running thereon, to prevent an efficient service and fairly successful system of rapid transit to and from the suburban districts of the city.

It can be readily seen, however, in a glance at the map of electric railways heretofore referred to, that many problems necessarily have arisen since the advent of so many interurban lines, because of their unavoidable occupancy of certain portions of the street railway tracks formerly used exclusively by city street cars, for the obvious reason that all lines aim to reach the heart of the city.

The advent of all these lines has taken place within a period of five years, which is, within itself, a remarkable fact. It can, therefore, readily be seen why there has, as yet, been no satisfactory solution of the problem of interurban electric railway terminals in this case, however essential and important are the requirements urging the necessity of a speedy settlement.

The conditions or the most successful and satisfactory operation of interurban or city street railway lines in any city are, at first, as mentioned heretofore, the handling of all passengers as nearly as possible at a central and common point in the city, providing for a possible union passenger station, the advantages of which are plainly manifest. If practicable, it would be likewise an advantage if a central union freight station could be made pos-

sible in conjunction therewith. This, it may be, will not be found feasible should a test be made under conditions that now or will eventually exist.

There is one principle that should be recognized and respected as between any city and the street and interurban railways of importance which see fit to invest the same. It is that in consideration of the cheaper and better service afforded by these lines, thereby bringing into contact with the city to enhance her business interests so many additional people, and because of the advantages to her own citizens, facilitating travel between the various portions of the city and adjacent country and towns by means of frequent and excellent service, the city is, in turn, bound to yield, in some degree, certain grants and privileges to companies which desire the use of streets and thoroughfares for these purposes.

It is sufficient, and, at the same time, just that the city should be fairly and equitably recompensed as a return for any such concession, the same to be governed, however, very much by the conditions whereby it becomes possible for any company so favored to render, in turn, such recompense. However, the possibility of cheap and frequent service should not be prevented by too stringent enforcement of this right.

Rather than dispense with or keep out any line that is of sufficient public and business advantage, a city had better exact no restrictions other than sufficient to restore the city and enough to protect the property and vested rights of her citizens in the use of streets and other thoroughfares. This may be regarded as an extreme attitude favoring the admisison of interurban lines, but it is not when all the conditions named and implied are given their proper consideration.

There is no doubt that there are instances when, after a successful operation of lines for a continuous period, that conditions will permit additional restrictions and exactions on the part of cities traversed successfully by the lines of certain companies, when the times comes for a renewal of the franchise. In that event, a fair business ararngement should be effected, however, with a proper view to precisely the same considerations.

There is manifest wisdom in the law that provides for a comparatively short term franchise, so that rectification of any inequitable terms may be attainable at proper intervals.

From the fact that there has been no concentrated or marked effort to bring the city officials and the managements of interurban and city street railway lines in the city of Dayton together in a fair discussion and determination of this matter, but very little has been accomplished in the direction of attempting or completing a satisfactory plan for better electric railway terminals.

There is a more or less justifiable disposition on the part of our city officials to withhold any concessions to railway promoters and

because of the fact that Dayton is inflicted with a number of unsatisfactory bridges in the reconstruction of which the street railways under existing franchises are required to do but a trivial part, which is very much objected to by many.

It will be necessary, in the near future; in fact, is absolutely so now, to improve and enlarge some of the bridges referred to in order to afford a proper means of carrying interurban cars, as well as for the sake of general appearances, and for what is more important, to satisfy the requirements of a city so far advanced in all other respects. The condition of affairs is indeed deplorable if matters cannot be equitably arranged between the railways and the city to accomplish this end so necessary.

It is reasonable to suppose that, in order to secure a proper disposal of the matter, a getting together on the part of the city officials and the numerous companies in question is not an impossibility, and this difficulty should soon terminate.

It will probably not be done, however, until a scheme is properly devised by some one capable of this achievement encompassing both the problem of better interurban electric railway terminals, and other needed street railway facilities, and the rebuilding of bridges, and in the event that the matter is disposed of in a manner that in itself is fair and equitable, it will not only be satisfactory at present, but will meet the requirements that are likely to exist in the future.

Reference is here made to a plat showing the streets upon portions of which the cars of all city and interurban railways of Dayton are now brought to pass.

The present condition is unsatisfactory principally from the fact that there is no common point of terminus.

By a reference to the plat showing the four blocks of the city bounded by Third, Fifth, Ludlow, and Jefferson streets, it is suggested, first, as a step in the right direction, that additional curves as shown be put in on Third and Fifth streets at the intersections of the same with Ludlow, Main, and Jefferson streets. This will perfect a main loop and two loops within the main loop available to all lines, with the addition of no tracks on the main thoroughfares in the city. This may prove sufficient for a number of years.

For a system of terminals that will be most effective here after, following out the above plan at some later day, as the requirements develop the construction of a system of double tracks and curves, as shown between Ludlow and Jefferson streets, on Fourth Street, is suggested, whereby it will be posisble for all cars to pass over or be brought to the corner of Main and Fourth streets by means of the four smaller loops within the one large loop, as shown, perfecting the possibility of a common terminal nearest the center of the city in probably the easiest and best manner attainable. It might mean, later, the construction of two additional tracks from

Third to Fifth Street on Main Street, and it is certainly not to be deplored that this may become necessary in consideration of the benefits to be derived, as the resulting advantage to the business interests would certainly justify this additional inconvenience. The advantages of this system can be seen better by a study of the plan.

To attain a satisfactory union passenger and freight interurban street railway depot, a plan might be adopted to the advantage of the city, and as well be best to all concerned, by which the site of the present city building and abutting drives known as North and South Market streets might be utilized, as shown on the same plat.

There are many points that might be offered as arguments in support of this proposition, among which is one that the city has long been on the lookout for a site for a new and more commodious city building, and the disposal of the old building to advantage in this manner might render this posisble at some future time, and, in addition, furnish, in part, the necessary means.

Should the building be abandoned for its present uses and adopted in this way, in case that it should not be sufficient in size for all the required uses the various railway companies might secure in conjunction therewith for additional freight and office facilities the business houses fronting on North and South Market streets now owned by private individuals.

This plan is, of course, a mere suggestion among numerous others that might be offered, yet by which the city might solve this important problem, and, at the same time, profit materially and as well wipe out the difficulties that now exist with the interurban and city street railway companies.

It is a matter of no little importance that every phase in the solution of this great problem should be given prompt but careful consideration before decided action. The interests of the railway, the traveler, the merchant, and the city should have due attention. This involves not only the exercise of closely directed economic and business judgment, but also the careful discrimination of the engineer. It devolves upon him to cope with and solve in a most satisfactory way not only what the present conditions require, but to prepare, as nearly as is now practicable, to meet the possibilities of future requirements. [Applause.]

PAVEMENT BASE MADE OF FURNACE SLAG OR CINDER.

By William Wilson.

Brother Engineers: The question of a good foundation for pavement is one which the engineer necessarily gives considerable thought, and the question arises, what is the best at the least cost? Therefore, I wish to present a few observations in reference to Furnace Cinder as a foundation. I will say that we have a pavement of asphalt block, over four years old, laid on furnace cinder six inches thick, that has given entire satisfaction, as the pavement is in first-class shape at this date. We have taken up the pavement at different places on account of fixing sewer and water connections, and have found that the foundation or base was as hard as concrete, and, in fact, it was harder and adhered better than some concrete that I have seen taken up.

Furnace and Mill streets have been laid about one year, using six inches of furnace cinder as the base and asphalt block on top, and through Furnace and Mill streets and the intersection on Main Street it was necessary, about nine months after it was laid, to tear up a strip about ten feet wide for the purpose of laying a street railway track through the center of the streets, and when the base was taken up they had to use iron bars to pry it up with, and also sledges with which to break it so that it would pry out; in fact, it was holding together and was stronger and in better shape than concrete generally is, especially when put in with some of the common cements. We paved a thirty-six foot roadway about one mile in length this last fall. The work was done in the months of November and December, and was through within fifty days, bad weather included, but if we had used concrete instead of cinder base it would have been impossible to have gotten it completed this last fall, and the freezing weather would have affected the concrete, and I am satisfied that in using furnace cinder for the base that we have as good a street as though it were concrete. Our specifications call for the foundation to be not less than six inches thick, after having been rolled with a steam roller not less than twelve tons in weight, and as the rolling progresses, fine or limey cinder is to be spread on the top of the foundation, so that there shall be no voids into which the sand cushion can be forced. When we find soft or spongy places not affording a firm foundation for the base it is dug out and generally refilled with furnace cinder, the cinder is broken up with napping hammers after being spread on the street and then rolled in about three layers. We thoroughly roll all our work from the foundation to the top, as I believe that rolling is one of the most essential parts of making a good pavement. We use cinder from any of the furnaces in the Mahoning Valley, as there is not enough difference in the cinder to materially

affect the base. Furnace cinder certainly has good cementing qualities in it, for at Youngstown, Ohio, The Brier Hill Iron & Coal Company make cement from their furnace cinder, and it is a good Portland cement that has exceptionally good setting qualities, as it gets very hard, and will show good tensile strains, and the cement is taking quite a lead in the eastern part of this State and the western part of Pennsylvania, as the steel plants and various other concerns have used a great deal of it in their foundation work, and it has been used in the viaducts of Youngstown, and there is no room to doubt the merits of the cement. Therefore, if an A No. 1 Portland cement can be made from furnace cinder, why can we not use furnace cinder for a foundation with those cementing qualities in it which they can make into Portland cement, therefore making a better furnace cinder concrete foundation than any that could be made out of limestone mixed with sand and cement, and what is generally used is common hydraulic cement, which certainly cannot be as good as the Portland. At the Brier Hill Iron & Coal Company's furnace they have a wall built from furnace cinder, just as it was taken from the furnace, and the wall has been in for two or three years, and it is as hard and firm now as at any time since it has been built, therefore showing that the frost has no effect whatever upon it. They also have several walls built, some of them with one part of cement to ten of cinder, and others have one part of cement to twenty parts of cinder, any they make excellent walls. In Youngstown, cinder foundation was put in on Wick Avenue, with brick pavement on top. After a number of years of wear, the brick gave out, and sheet asphalt was laid over the paving brick, and it is said to have made a very good job. Phelps, Hazel, Boardman, Market, and Commerce streets, located in the center of the city, had furnace cinnder for a base. The streets that I have mentioned are all very old brick pavements, and they have all been covered with sheet asphalt except on Boardman and Commerce streets and one square on Hazel Street, but there has never been any question in regard to the foundation, for in digging through it for pipes it has always shown very fair as far as the foundation was concerned. I am informed that Akron has laid thirty-two different streets and parts of streets, using eight-inch cinder base, commencing in 1890, and one street with six-inch base was put down in 1898. Paving brick was laid on all but two of these streets, one street laid with asphalt block on the six-inch base, and one street with asphalt block on the eight-inch base. It would seem, from these facts, that it has been giving good satisfaction in the city of Akron. I have used furnace cinder in foundation for machinery and such like, and it has given good satisfaction, and, in conclusion, will say that I am a very strong advocate of furnace cinder for the base of pavements. [Applause.]

Mr. Kemmler: "I want to ask Mr. Wilson whether he has figured the cost of six-inch cinder base and six-inch cinder base with natural cement."

Mr. Wilson: "You mean the comparison? I would say that it would cost about a third of what the other would cost."

Mr. Kemmler: "That is, mixing cinder into concrete with cement or natural cinder?"

Mr. Wilson: "I mean natural cinder and using concrete. We find that we can probably get our cinder put in for about eight or nine cents a square yard, after being thoroughly rolled. Our concrete foundations vary a good deal—in the neighborhood, possibly, of thirty cents."

Mr. Cronley: "You use the cinders alone?"

Mr. Wilson: "Yes; use nothing else but cinder; don't mix it with any cement whatever. We claim the cementing qualities are there to a great extent."

Mr. Neiderheiser: "Have you had any experience in using it in place of crushed limestone in macadam road? If so, what are the wearing qualities of slag when subjected to the usual traffic of a road? I heave heard its use advocated, and then heard other people say it was not any good."

Mr. Wilson: "I understand the question to be, whether it will make good macadam road. In my opinion, I would not want it for that purpose. The reason is, that the wheels would wear it away, eat into it. When you get your spring rains, and the water is coming down on there all the time, it would seem to grind into it. It is hard to get uniform in every respect. But cover that with a brick pavement, and you protect it, and it will last."

Mr. Sarver: "In answer to that question, I will say that I have had a little experience with using slag as a road metal. The first five or six months it was very nice, but it wears through in holes. I tried to dig up a monument in it one time, but had to give it up as a bad job. Another objection is, that the dust is so light than ordinary team makes so much dust that you can't see the team."

Mr. Ganyard: "There is a difference in the quality of furnace slag, as I found out. The fresh and new slag is more valuable than the old."

Mr. Sarver: "We use the light color—don't allow any black slag."

The Chair: "At Warren, Ohio, we have used slag for the lower part, or base, of macadam road, then covering with broken limestone, and it makes a very nice macadam road."

Mr. Neiderheiser: "I think there is no question about furnace cinder making a good foundation. One of the best streets in our city is of that kind of foundation, six inches. It has been down

two years, and have had no occasion to tear it up, but I know the top is just as it was when put down—the brick on top."

Mr. Wilson: "We have our cinders all shipped in, although we have a furnace there. It is as expensive to get them there as from other furnaces in the valley, because the railroad companies have contracts to take them from the furnaces at all times of the year, so we have to go to the railroad company to get our cinder we have to do our experimenting with them."

Mr. McKay: "What is the charge for the cinders?"

Mr. Wilson: "Nothing beyond the railroad company's charge for freight. We get the cinders delivered from two and a half a car up to eight. It varies in that way."

VERTICAL CURVES.

By Lewis A. Amsden.

In applying the principle of the parabola to vertical curves, the undersigned claims nothing new, but he does claim that the following formula is more simple than that in any work of reference that he has access to.

Space off an equal number of spaces each way from the change of grade.

Make the grade line having the greater gradient the base line, and mark the point of curve on the base line 0; if the gradients are equal, take your choice, but in all cases 0 must be at the P. C. or P. T. of the curve.

Commence at 0, mark each space 0, 1, 2, 3, 4, etc., until you have numbered each space; consider each space as an independent station and calculate the gradient for a station on the base line, basing it upon the regular gradient and the number of feet in each space or station.

Extend the base line A. C. (figures 1, 2, 3, 4 and 5) to B., which is a point directly over or under, as the case may be, the last station or P. T.

Calculate the elevation of B. and of the last station or P. T., and divide the difference in elevation by the square of the number of the last station: this is the drop or crown for sta. 1; the crown of the other stations is found by multiplying the crown of sta. 1 by the square of the number of the sta. that you wish to find the crown for.

Multiply the gradient by the number of the sta., subtract from

the product the crown for the same sta.; the remainder is to be added to the elevation of sta. 0, if the P. T. is higher than the P. C., or subtracted if it is lower than the P. C., if the gradients are equal, forming a $\vee$, it is to be added; if they form a $\vee$, it is to be subtracted.

The sum or remainder is the elevation of the vertical curve for that station.

Let n represent the last station.
g " " gradient.
c " " crown for sta. 1.
d " " difference in elevation between B. and the P. T.
x " " remainder that is to be added to or subtracted from the elevation of sta. 0 for sta 1.

Then $c = \frac{d}{n^2}$ and $x = 1\,g - 1\,c$.
x for sta. $1 = g - c$.
x " " $2 = 2\,g - (c \times 2^2)$.
x " " $3 = 3\,g - (c \times 3^2)$.
x " " $4 = 4\,g - (c \times 4^2)$.

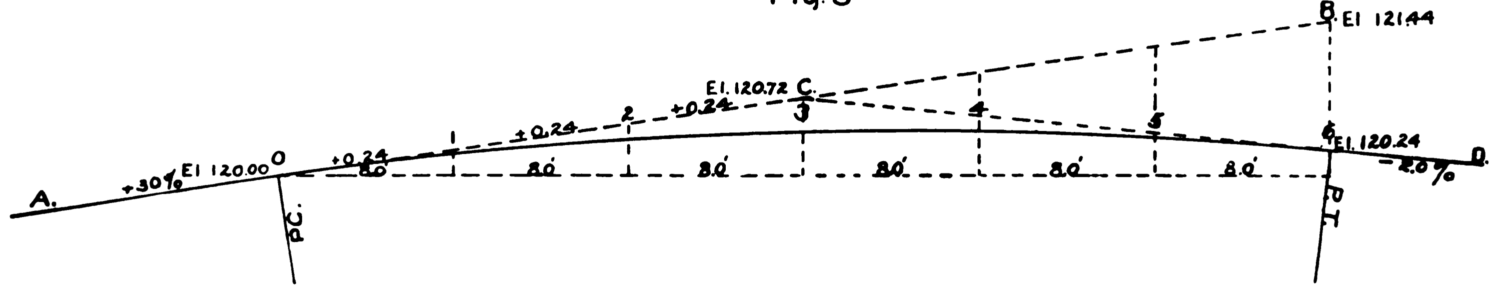
If the P. T. of the vertical curve is higher than the P. C., add x to the elevation of sta. 0.

If the P. T. of the vertical curve is lower than the P. C., subtract x from the elevation of sta. 0.

If the two grades are equal, forming an $\wedge$, x is to be added.

If the two grades are equal, forming a $\vee$, x is to be subtracted.

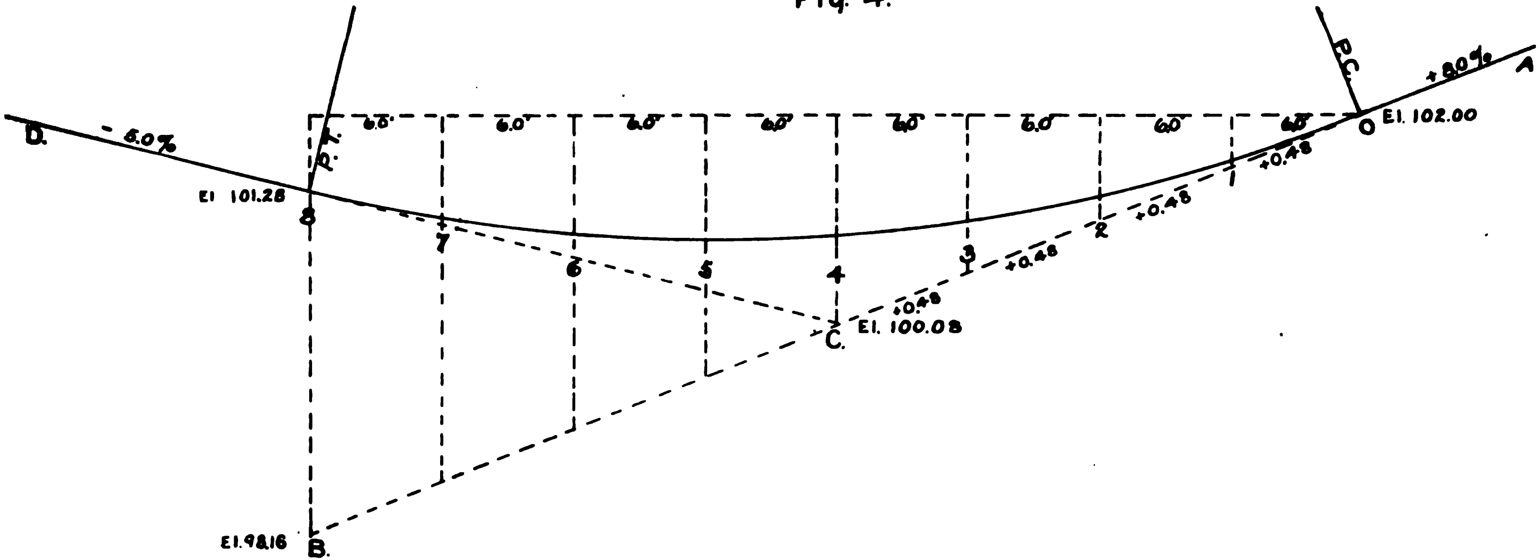
Fig. 3



$d = 121.44 - 120.24 = 1.20 \qquad n = 6 \qquad q = .24 \qquad c = \frac{d}{n^2}$

$c = 1.20 \div 6^2 = .0333$	1q = .24 − .03 = .21 = 1x.	120.00 + .21 = 120.21 =	1
$(c \cdot 2^2) = .0333 \times 2^2 = .1333$	2q = .48 − .13 = .35 = 2x.	120.00 + .35 = 120.35 =	2
$(c \cdot 3^2) = .0333 \times 3^2 = .2999$	3q = .72 − .30 = .42 = 3x.	120.00 + .42 = 120.42 =	3
$(c \cdot 4^2) = .0333 \times 4^2 = .5333$	4q = .96 − .53 = .43 = 4x.	120.00 + .43 = 120.43 =	4
$(c \cdot 5^2) = .0333 \times 5^2 = .8333$	5q = 1.20 − .83 = .37 = 5x.	120.00 + .37 = 120.37 =	5
$(c \cdot 6^2) = .0333 \times 6^2 = 1.20$	6q = 1.44 − 1.20 = .24 = 6x.	120.00 + .24 = 120.24 =	6

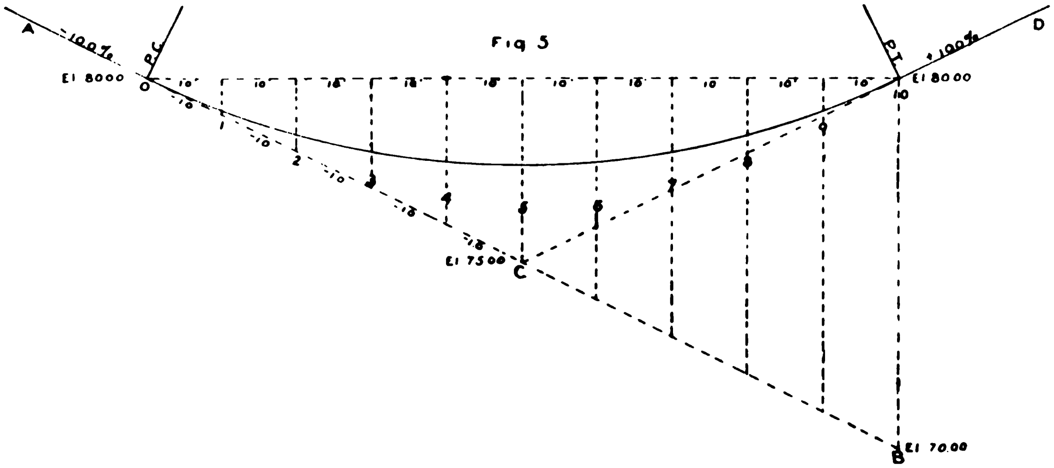
Fig. 4.



$d = 101.28 - 98.16 = 3.12 \qquad n = 8. \qquad q = .48 \qquad c = \frac{d}{n^2}.$

$C = 3.12 \div 8^2 = .04875$	$1q = .48 - .05 = .43 = 1x.$	$102.00 - .43 = 101.67 = 1$
$(C \cdot 2^2) = .04875 \times 2^2 = .195$	$2q = .96 - .20 = .76 = 2x.$	$102.00 - .76 = 101.24 = 2$
$(C \cdot 3^2) = .04875 \times 3^2 = .48875$	$3q = 1.44 - .49 = 1.00 = 3x.$	$102.00 - 1.00 = 101.00 = 3$
$(C \cdot 4^2) = .04875 \times 4^2 = .78$	$4q = 1.92 - .78 = 1.14 = 4x.$	$102.00 - 1.14 = 100.86 = 4$
$(C \cdot 5^2) = .04875 \times 5^2 = 1.21875$	$5q = 2.40 - 1.22 = 1.18 = 5x.$	$102.00 - 1.18 = 100.82 = 5$
$(C \cdot 6^2) = .04875 \times 2^2 = 1.755$	$6q = 2.88 - 1.76 = 1.12 = 6x.$	$102.00 - 1.12 = 100.88 = 6$
$(C \cdot 7^2) = .04875 \times 7^2 = 2.3887$	$7q = 3.36 - 2\ 39 = .97 = 7x.$	$102.00 - .97 = 101.03 = 7$
$(C \cdot 8^2) = .04875 \times 8^2 = 3.12$	$8q = 3.84 - 3.12 = .72 = 8x.$	$102.00 - .72 = 101.28 = 8$

Fig 5



$d = 80.00 - 70.00 = 10.00$ $n = 10$ $q = 1.0$ $c = \frac{d}{n^2}$

$c = 10.0 \div 10^2 = .10$	$1q = 1.00 - .10 = .90 = 1x$	$80.00 - .90 = 79.10 = 1$
$(c \cdot 2^2) = .10 \times 2^2 = .40$	$2q = 2.00 - .40 = 1.60 = 2x.$	$80.00 - 1.60 = 78.40 = 2$
$(c \cdot 3^2) = .10 \times 3^2 = .90$	$3q = 3.00 - .90 = 2.10 = 3x$	$80.00 - 2.10 = 77.90 = 3$
$(c \cdot 4^2) = .10 \times 4^2 = 1.60$	$4q = 4.00 - 1.60 = 2.40 = 4x.$	$80.00 - 2.40 = 77.60 = 4$
$(c \cdot 5^2) = .10 \times 5^2 = 2.50$	$5q = 5.00 - 2.50 = 2.50 = 5x$	$80.00 - 2.50 = 77.50 = 5$
$(c \cdot 6^2) = .10 \times 6^2 = 3.60$	$6q = 6.00 - 3.60 = 2.40 = 6x.$	$80.00 - 2.40 = 77.60 = 6$
$(c \cdot 7^2) = .10 \times 7^2 = 4.90$	$7q = 7.00 - 4.90 = 2.10 = 7x.$	$80.00 - 2.10 = 77.90 = 7$
$(c \cdot 8^2) = .10 \times 8^2 = 6.40$	$8q = 8.00 - 6.40 = 1.60 = 8x.$	$80.00 - 1.60 = 78.40 = 8$
$(c \cdot 9^2) = .10 \times 9^2 = 8.10$	$9q = 9.00 - 8.10 = .90 = 9x.$	$80.00 - .90 = 79.10 = 9$
$(c \cdot 10^2) = .10 \times 10^2 = 10.00$	$10q = 10.00 - 10.00 = .00 = 10x.$	$80.00 - .00 = 80.00 = 10$

Lewis A. Amsden
Asst. Engr.
Ashtabula, O.

OUTLINE OF PROCEEDINGS.

The Twenty-second Annual Meeting of the Ohio Society of Surveyors and Civil Engineers, which was held at the Great Southern Hotel, Columbus, Ohio, was called to order by the President, Homer C. White, Monday evening, January 21, 1901.

The report of the Secretary, F. J. Cellarius, was read and adopted.

The report of the Treasurer, F. J. Cellarius, was read and referred to the Trustees.

A paper on "Vertical Curves," by Lewis A. Amsden, was read.

Tuesday, January 22, A. M.

The President gave his annual address, after which papers were read by Prof. C. N. Brown, "A Review of the Engineering Progress During the Nineteenth Century"; by J. B. Strawn, "Portland Cement and Some of Its Uses"; by J. C. Cronley, "Elementary Mechanics"; by F. J. Cellarius, "The Riverdale Sewage System and the Shone Pneumatic Ejectors."

The following nominating committee was appointed: Messrs. E. A. Kemmler, B. F. Bowen, and J. B. Strawn.

On motion, the Chair appointed the following committee to prepare suitable resolutions on the death of John W. Stump: Prof. C. N. Brown, R. E. Kline, C. E. Sherman.

Tuesday, January 22, P. M.

The Society, upon invitation, visited the Ohio State University and various manufacturing plants.

Tuesday Evening, January 22.

Upon motion, the following committee was appointed to prepare resolutions relating to the character of maps and work done by the United States Geological Survey in charge of the Topographical Survey of Ohio: Messrs. J. B. Strawn, R. E. Kline, and F. J. Cellarius.

A paper on the "Comparison of Methods of Computing Earthwork" was read by Prof. W. H. Boughton; also, a paper on the "Municipal Improvements of Shelby, Ohio, During the Year 1900" was read by Mr. J. B. Weddell.

ELECTION OF OFFICERS.

"Is the Committee on Nomination of Officers ready to report?"

Report as follows:

"To the President and Members of the Ohio Society of Surveyors and Civil Engineers.

"GENTLEMEN: Your committee appointed for the purpose of nominating officers for the ensuing year respectfully begs to submit the following report: For President, A. W. Jones; Vice-President, F. L. Neiderheiser; Secretary-Treasurer, F. J. Cellarius. For Trustees: Homer C. White, Prof. C. N. Brown, William Wilson, J. B. Weddell, R. E. Kline.

"(Signed.)

"E. A. KEMMLER,
"B. F. BOWEN,
"J. B. STRAWN,
"Committee."

Secretary Cellarius: "Mr. President and Members of the Society: Before you act on this report, I wish to state to this Society that I desire to be relieved from this office the coming year, and ask that my name be withdrawn from consideration. It is not that I do not want to serve the Society, because I have found the work exceedingly pleasant, and I feel that every member ought to do his share of the Society work, but I feel that, in the coming year, I cannot give to the office the time that it requires to do justice to the Society, and therefore ask to have my name withdrawn."

Mr. Strawn: "I believe it is the experience of those longest connected with the Society that if you have an office with a good deal of work in it, pick out the busiest man in the whole Society, and you will have it done better than if you pick out the fellow who hasn't anything to do, and it will be done more promptly. I don't want to impose a burden on Mr. Cellarius, but I feel that his services as Secretary-Treasurer have been so eminently satisfactory to the Society that we should thank him with our whole hearts for the sacrifices he has made for the benefit of the Society, and earnestly ask that he continue to serve us. I am sure I voice the sentiments of the whole committee."

Secretary Cellarius: "I appreciate the kind words of Mr. Strawn, but I feel that I have not the time to give to the office that it demands."

Moved by Mr. Huston (seconded) that the report be received. Carried.

Moved by Professor Brown that the rules be suspended, and the President instructed to cast the ballot of the Society for the officers named in the report of the committee. Seconded by Mr. Strawn. Carried.

The President proceeded to cast the ballot, as directed, and de-

clared the officers above named in the report of the Committee on Nomination of Officers to be duly elected for the ensuing year.

The President: "Now we can make the work of the Secretary a good deal lighter than it has been if we will all work with him. If we just go home and let the matter drop, he will have to bear the burden, and we will have nobody to blame but ourselves if he acts like the rest of us and lets everything go. I for one feel like helping him, and will do better than I did last year, I assure you."

Mr. Strawn brought up the matter of assisting the Secretary in the way of securing advertisements for the published proceedings, the members each securing what they might be able from among their home firms. This he had done, and was still able to do.

Mr. Wilson, of Niles, agreed with Mr. Strawn, and stood ready to pledge himself to secure advertisements, and called upon other members present to make a like pledge, and in this way solve the difficulty.

Professor Brown: "I have a little matter here I have been asked to present to the Society. I will say a few words in regard to it, and leave it for consideration of the Society until to-morrow. It is in regard to the establishment of the proposed National Standardizing Bureau by the national government at Washington. The idea is to establish a bureau for the standardizing of all sorts of instruments used in engineering and scientific work, anything at all used in the way of accurate measurements. There is no such bureau in this country, and for scientific work it is necessary to send instruments to Germany to have them properly standardized. Such a bill has been introduced, and the friends of the bill wish to bring as much pressure as possible to bear, so they ask this and similar societies to consider the matter, and if they think wise to say so in some sort of resolution. I will leave these pamphlets on the desk, and any member who cares to can look them over. I have no special recommendation to make, except that I think it is probably a good thing. It is not connected with the adoption of the metric system, but is another matter entirely."

The applications for membership of John C. Ward, German Warner, G. G. Cole, W. E. Sarver, Prof. William Boughton, E. C. Baird, R. S. Sharts, L. B. Ganyard, and W. H. W. Jenkins were read and balloted upon, resulting in the election of those gentlemen to membership.

On motion of Secretary Cellarius, the matter just brought before the Society by Professor Brown, referring to the proposed Standardizing Bureau, was referred to a committee of three for examination, and report to this Society. The Chair named as this committee: Professor Brown, F. J. Cellarius, and J. B. Strawn.

On motion of Mr. Wilson, meeting adjourned.

Wednesday Morning, January 23.

The meeting was called to order by the President, who, upon announcing the first and second numbers on the program, found that neither gentlemen were present. Mr. W. H. Jennings, a former member of the Society, having consented to read a paper descriptive of the work of the Michigan Railroad Appraisers, was called upon at this time, and responded.

Mr. Jennings gave a *resume* in detail of the manner in which this work was carried on in Michigan, and, as he was one of the corps of experts engaged for this work, his information was especially valuable and interesting, as being gained from personal contact with the work. He stated that the work had been the most complete and systematic ever attempted by any State for the purpose of determining the value of the railroads within a State, and the precedent established by Michigan would, in all probability, be followed by similar action on the part of other States.

It was not Mr. Jennings's wish to have the paper published at this time, but such of the discussion of same as is intelligible without connection with the paper is presented.

Mr. Cronley: "I would like to ask the writer of the paper whether he can take any single railroad in the State of Michigan, after having determined the value of its right of way, rails, rolling stock, bridges, etc., and state what the average cost or value is per mile."

Mr. Jennings: "The results were all tabulated, but I don't know what the result was. The figures were all tabulated by the computors in the office, and I saw very few of the final figures. As soon as completed, they were turned over to the tax commission, and a special session of the legislature called."

Mr. Cronley: "How much did it increase the tax on railroads?"

Mr. Jennings: "About one hundred per cent. That paid for the commission's work. If they could not find the tangible value, they put on an intangible value on the franchise, to make it more."

Mr. Peters: "Is it possible to obtain copies of these reports or the finding of the commission?"

Mr. Jennings: "I don't know just how that would be. The reports would be rather expensive. They would go to the legislature and undoubtedly be printed and probably be accessible. The railroads which have a lot of watered stock, the stockholders and bondholders and men financially interested in it will want to know something about it. The result will certainly be beneficial, whether the result measured up to expectations or not. We did not take taxes into consideration at all."

Professor Brown: "This whole subject is rather difficult to discuss, because we all know so little about it, practically nothing. It is entirely along new lines. Nothing has ever been done like it in the United States, and these gentlemen were pioneers in this

line, and had to work it out entirely themselves. It seems to me they have done the work well, and it seems very probable that other States will take up the same idea, and, in the next decade or two, will follow out the same idea. Then the Michigan work will be looked back to and referred to as the basis for such work. This paper has been exceedingly interesting, and I hope the whole report of the work will be published, with as many details as possible, so that it will be accessible to engineers. No doubt, the general results will be published."

Mr. Wilson: "I was much pleased to listen to that report, and will say that the commissioners of Trumbull County have undertaken to measure up all the switches in the county, to see if the property was properly taxed, and whether the value was about right. If I remember rightly, one of the commissioners referred to said something about what they were doing in Michigan, and I believe that is what gave him the idea."

Mr. Cronley: "Will this not do away with auditors' passes? There is not a common pleas, circuit, or supreme judge or county auditor who does not carry a pass in his pocket over any road he sees fit to ride over. And it occurs to me that if it does away with the pass business, the county auditor carrying a pass when he is taxing the railroads, it will be a good thing, if it does nothing more. I never could understand how the county auditor had such knowledge of railroads as would make him competent to assess them. It seems to me this, on its very face, suggests something in the right direction. The law may not be perfect in its operation or construction, but it lays a basis upon which I believe a perfect system of taxation can be built. I was highly pleased with the paper, the subject being entirely new to me."

The Chair: "I will say, in reference to the measuring of switches in Trumbull County, that the results we have been obtaining do not show that the railroads have been perverting the facts, as we have not gained enough to pay the commission expenses."

Mr. Cronley: "It is not the length of them, but the value."

The Chair: "They have a certain value on right of way, on main track, and mileage of switches, which is determined without much regard for value of rails and the track itself."

Professor Boughton: "In that connection, I will state that I have read regarding the work of the Michigan Commission that they discovered a considerable number of railroads that had not been listed at all, not chartered or paying any tax as railroads. The owners of the land paid taxes as owners of the land as such, but the railroads, as such, had not been listed for taxation."

Mr. Peters: "I understand that the railroad companies have all their property listed as right of way in these small cities and towns. They may have buildings or may be lots not in use at all,

but all listed as right of way. I don't know how it comes to be, but it seems to me to be very wrong."

Mr. Jennings: "I may be able to throw some light on that subject, as I have reported railroad taxation for some years. A tract of land in the country has been thrown into right of way. If there is no railroad on it, it pays taxes the same as anything else. For all land not used for railroad purposes taxes are paid the same as by anybody else. Take the Hocking Valley. It has a certain number of acres in Columbus on which is a railroad; that goes into track mileage. A value is put on the track at so much per mile, which includes the right of way. If there is no railroad on it, it is estimated the same as other property. The buildings go into the property value, not with the track."

Mr. Peters: "I know of some lots that have no track on them, some used as coalyards, some not used at all, and all put in as right of way and nothing else."

Mr. Jennings: "That is not right. I was speaking of my own work."

The Chair: "We will hear the report of the committee appointed to draw up resolutions regarding the United States Topographical Survey."

Mr. Strawn read the following report:

"WHEREAS, The past quarter century, in this country, has witnessed unprecedented progress and development in the building of railways, and especially the introduction of the electric railways, the opening up of and developing our vast mineral resources, the utilizing of our rivers and streams for power to drive machinery and for public water supplies, has emphasized the importance and value of accurate geographical and topographical maps of our State, the establishment of accurate and reliable geographical reference points, and of well defined bench marks from precise leveling; and,

"WHEREAS, It has been brought to our notice that the methods used by the United States Geographical Survey do not secure the accuracy and precision we think desirable, in both levels and location of points; also, that their maps do not show many features, such as electric railway lines, churches, school-houses, factories, mines, section lines, and numbers, etc., all of which could be added with trifling expense; therefore,

"*Resolved*, That we beg your honor to investigate and consider the foregoing points, and such other valuable features as shall secure for Ohio a map that shall be of general value to the State and of special value to the engineers and surveyors of Ohio.

"(Signed.)

"J. B. STRAWN,
"ROBERT E. KLINE,
"F. J. CELLARIUS."

On motion of Professor Brown, the foregoing preamble and resolution was adopted, and the Secretary instructed to transmit a copy of the same to the Governor.

The following report of the committee appointed to investigate the proposed establishment of a National Bureau for the standardizing of instruments was read by Professor Brown:

"WHEREAS, There is now no adequate means in this country for the standardizing of apparatus used in engineering work, scientific research, and in the mechanic arts; therefore, be it

"*Resolved,* That the Ohio Society of Surveyors and Civil Engineers heartily approve the present movement for establishing a National Standardizing Bureau, with a suitable laboratory for its maintenance, as outlined in House Bill 11,350, First Session, Fifty-sixth Congress.

"(Signed.)

"C. N. BROWN,
"F. J. CELLARIUS,
"J. B. STRAWN."

On motion of Mr. Kemmler, the above resolution was adopted, and Secretary ordered to transmit copy of same to the proper parties.

Professor Brown presented the following report of the Board of Trustees:

"The Trustees of the Ohio Society of Surveyors and Civil Engineers beg leave to report as follows:

"We have examined the report of the Treasurer, and find that the moneys received have been properly accounted for, and that the books balance.

"We would urge the Society to take proper measures toward the prompt payment of the old bill for printing.

"We have examined the applications of the following persons, Geran Warner, W. H. W. Jenkins, G. G. Cole, W. E. Garver, and recommend them for election as members: John C. Ward, Prof. Wililam Boughton, E. C. Baird, R. S. Sharts, L. B. Ganyard.

"Respectfully submitted,

"(Signed.)

"C. N. BROWN, *Chairman,*
"G. A. MCKAY,
"E. A. KEMMLER."

Moved by Mr. Strawn, second by Mr. Neiderheiser, report of Trustees be received and adopted. Carried.

During the discussion which followed, the payment of the old debt referred to was strongly urged by various members, those present as well as absent members being urged to bestir themselves in

the matter of securing advertisements for the forthcoming volume in order to set the Society square. Mr. Kemmler pledged himself to fill one page, as did Mr. Wilson last night, and thought others might well do the same.

Mr. Strawn here asked the privilege of the floor in order to present an amendment to By-law No. 9, he being obliged in a few minutes to leave in order to catch his train. This privilege was granted, and he presented the following:

"To amend By-law No. 9 so that it will read: "Applications for membership, at other times than at stated meetings of the Society, may be made to the Secretary-Treasurer upon compliance with the rules for the admission of members, after which the Secretary shall, within thirty days thereafter, send letter ballots to all active members, which ballots must be returned within thirty (30) days thereafter to the Secretary, who shall notify the applicant of the result of said ballot."

Mr. Strawn: "I move that By-law No. 9, as read, be adopted.

Seconded by Professor Brown.

Mr. Bowen offered the following amendment to Mr. Strawn's amendment: "That the President and Secretary be authorized to cast the ballot for those desirous of joining the Society in the interim, upon the filing of the same recommendations as otherwise required."

Seconded by Mr. Cronley.

Amendment of Mr. Bowen, upon being put to vote, not carried.

Following amendment to Mr. Strawn's amendment, offered by Mr. Kline: Instead of referring to the individual members of the Society, "that all membership applications be reported to the Board of Trustees during the interim, and on the favorable report of the Board of Trustees, the President and Secretary be authorized to cast the ballot."

Seconded by Professor Brown.

Upon vote, amendment offered by Mr. Kline adopted.

Thereupon the following amendment as amended was adopted:

"By-law No. 9: Applications for membership, at other times than at stated meetings of the Society, shall be reported to the Board of Trustees during the interim, and on the favorable report of the Board of Trustees, the President and Secretary shall be authorized to cast the ballot, and the Secretary shall notify the applicant of the result of said ballot."

The Chair then called for the vote upon the motion of Mr. Strawn for the reception and adoption of the report of the Board of Trustees. Motion carried.

Mr. Wilson moved that Article 4, Section 3 of the Constitution, which reads, "The President shall appoint three members to put in nomination the officers," etc., be referred to the Board of Trustees, to be reported on upon the first day of our meeting next year.

Seconded by Professor Brown. Adopted.

The committee on resolutions upon the death of Mr. Stump asked for further time in which to prepare the same, promising to have same ready for publication in the proceedings of this meeting.

Upon motion of Mr. Wilson, said request was granted.

Professor Brown said that it might be of interests to hold one or more sessions of next year's meeting at the University, with the possible provision of a lecture on some subject of interest illustrated with lantern slides, or some other departure in the routine of these meetings. The suggestion was well received, and the matter left in the hands of the Board of Trustees for determination and arrangement, it being understood that the meeting is to be held in Columbus.

Upon the invitation of the Chair, Mr. Frost devoted a few minutes' talk to the methods employed by other similar societies in this country and abroad for inciting interest in and increasing the attendance at the meetings of the same, it being the policy of these societies to provide atttractions of sufficient interest to induce the people to join the societies and come to the meetings. Among attractions of this nature, he mentioned the exhibition and explanation of the workings of the Maxim gun by its inventor before an English society, the construction of an immense dam by a prominent engineer before another society, the report of Mr. Parsons before the American Society of Civil Engineers regarding conditions in a certain portion of China hitherto unpenetrated by foreigners, whither he had been sent to investigate and report upon railway prospects, etc. Other societies added to the general interest in their meetinges by dinners, banquets, with short speeches, etc., the tendency being to make the character of these meetings more and more social, thus attracting the vast army of men who are, during the rest of the year, working hard at their profession, isolated to a certain extent from each other, as is the case with civil engineers. Secretaries of these societies, the speaker thought, should be paid, as they were in many of these societies, and be enthusiastic in the work, spreading their enthusiasm to others.

Mr. Jennings here stated that he was reminded by hearing Mr. Frost speak, that the *Engineering News* would, without doubt, contain a full account of the work of the Michigan Commission, and suggested that those wishing to read the same would, no doubt, find it in this periodical, though Mr. Frost was unable to state what number of this publication would contain this matter.

The Chair: "I thank the gentlemen of the Society, one and all, for their hearty support throughout this meeting, and assure you that I have fully appreciated your kindness.

"It has been moved and seconded that we adjourn, with an inward resolve to help the Secretary all we can to make the next meeting better than ever. All in favor of this motion, saye Aye.

Adopted unanimously.

Thereupon the meeting adjourned.

REPORT ON LEGISLATION.

G. A. McKay.

As chairman of your Committee on Legislation, I beg leave to submit the following in the way of a report. Owing to the fact that some of the committee resided in remote parts of the State, it was impossible to get the committee together without considerable expense, as much as we would have desired to have the assistance and a full discussion and opinion of each member upon this important subject. Consequently we had to rely upon correspondence.

Brothers Varney, of Cleveland, and Kemmler, of Columbus, have responded to my request for views upon this subject.

The engineer and surveyor is a public servant differing from that of the doctor, lawyer, or other public servant in many respects. In his employment he generally stands as referee between the promoter of enterprises and the contractor who executes the work. He designs the plans and specifications upon which all important undertakings are executed or carried forward, and if honest (and generally he is) requires the contractor to fulfil his obligation to his employer honestly and justly, as well as that his employer shall fulfil his part of the contract toward the contractor.

In this particular his profession differs from that of most others, and it seems to me that from the very nature of his calling the engineer is especially fitted to suggest and promote legislation suitable to and necessary in the conduct of public affairs. However, it is slow work to convince people in general that he has well grounded claims to professional recognition, and that by education and training the engineer is a man of high professional knowledge, in most cases having spent many years in securing his education and practical knowledge that make his services both desirable and profitable to his employer.

The field for engineering talent and skill is so broad and diversified that it is almost impossible to suggest or recommend legislation that will meet with approval from even a majority of the engineers and surveyors of the State.

Certain measures have been recommended to the Legislature for passage by this Society which met with much opposition from surveyors and engineers in some sections of the State. This was

true of the bill presented a few years ago proposing to license surveyors, and also true of the legislation proposed in behalf of the public last year in reference to matters in which the engineering and surveying profession would seem to have been interested.

Most of the statutes now in force in this State relating to surveying and engineering are very old, and are not adequate to present needs—a fact that is fully recognized by some of our legislators and public officials, and the only reason that more effort has not been made to remedy the matter is the lack of knowledge how to proceed.

To be sure, some attempts have been made to improve the engineering service of the State by certain amendments to the statutes, but some of these are of doubtful public benefit, especially the one requiring all the county work to be given by the Commissioners to the County Surveyor. If the County Surveyor is a capable and competent man, then it is all right and proper; if not, the public suffers from poor service.

From an experience of eight years as a County Surveyor, I am convinced that laws requiring more engineering control in the way of plans, specifications, superintendence, estimating and certifying the amount due the contractor, would be a great public benefit and saving—not that the parties who have these matters in charge are dishonest, but, from the lack of knowledge that can only be acquired by special education and engineering practice, they are unable to design or direct work in an economical manner.

The interest of the public and the engineer are so closely allied that legislation that will be beneficial to the public in public expenditures must of necessity benefit the engineer by increased demand for his services at least. While perhaps it is not wise for us as a Society to be too active in matters pertaining to legislation, I think the engineers and surveyors of the State capable of formulating and promoting needed and desirable legislation. They know and understand the conditions that exist in the conduct of public affairs and should be capable of giving their representatives information that would enable them to formulate bills or vote intelligently upon any such measure that might be proposed.

While the efforts of your committee before the last Legislature were not successful in securing any actual legislation, yet we do not feel that the effort was entirely fruitless. I believe that we made a favorable impression on many of the members and committees with whom we had to deal, and the time and labor so spent may bear some fruit in the future. We received very courteous treatment by the committees and were listened to with an interest that was evidence that we had respectful consideration if nothing more.

Several reasons might be assigned why we were not successful. Some of the surveyors and engineers of the State that we natu-

rally supposed would be in favor of the proposed measures, influenced enough votes to defeat some of the bills. The principal reason, however, was the lack of knowledge on the part of members of the General Assembly that would give them a clear conception of the nature and practical utility of the legislation proposed.

Legislation, to be successful, must be of a general character, applicable, as near as possible, to all counties in the State, and *unquestionably* a public benefit, without the semblance of benefiting any class or organization.

The members of this Society represent such a small portion of the engineers and surveyors of the State, numerically, that any action pertaining to legislation that may be taken by the Society and proclaimed as such in a public manner, is likely to be looked upon by those on the outside with a degree of suspicion which may have a tendency to induce a state of indifference on the part of many.

According to Brother Varney's communication, it is the opinion of some of the committee that no action whatever should be taken by this Society to promote desirable legislation. However, I differ in opinion with him upon this point. We may meet and discuss and plan, but without organized effort and proper committees to look after the preliminary work at least, nothing will be accomplished.

I think engineers and surveyors as a society, and I think engineers and surveyors as citizens, are the most competent and perhaps the only persons who can suggest legislation that will give the desired relief to the public in matters where the interests of the engineer are connected.

Every organized interest in the State makes itself felt more or less in the Legislature, and we as engineers will have to do likewise or keep the back seat that we have occupied for the last century.

Report of Committee to Draft Resolutions on the Death of Mr. JOHN W. STUMP.

We, your committee appointed to draft resolutions on the death of John W. Stump, of Circleville, Ohio, beg leave to submit the following report:

WHEREAS, God in his wisdom has removed from us our fellow-member and co-laborer in the Ohio Society of Surveyors and Civil Engineers, Mr. John W. Stump, causing an irreparable loss in our membership; therefore, be it

Resolved, That this Society extend to the bereaved family and friends its deepest sympathies in the loss of a true friend and worthy citizen; and,

Resolved, That a copy of these resolutions be transmitted to the bereaved family.

R. E. KLINE,
C. N. BROWN,
C. E. SHERMAN,
Committee.

MR. JOHN W. STUMP

was born in Darby Township, Pickaway County, Ohio, December 26, 1863, and died in Circleville, Ohio, May 31, 1900. His early boyhood was spent on the farm of his grandfather, the late John Glassock, and later he resided in the western part of the same township on his mother's farm, but he could not persuade himself that such should be his life work. His early education and training were received in the schools of his native township. When but nineteen years of age he obtained a teacher's certificate and taught his first school in his home township.

Being highly ambitious, energetic and industrious, he resolved upon a course of study in the National Normal University at Lebanon. On leaving the University he resumed the profession of teaching and continued the same for a number of years, after which, in 1891, he entered the Ohio State University, taking the course in Civil Engineering, and graduating with honors in 1895. After graduating he was elected County Surveyor of Pickaway County, and re-elected in 1898 in both instances by handsome majorities. Mr. Stump performed his duties as County Surveyor with the same thoroughness and faithfulness to his trust that had always characterized his course in life, and won for himself the confidence and esteem of all, regardless of party affiliations His exemplary life will long be remembered by those intimately associated with him. He became a member of the Ohio Society of Surveyors and Civil Engineers in 1897. He manifested a keen interest in its meetings and by his presence and activity proved a valuable member to the Society.

SEC. 5. Any person desiring to become a member of this Society shall fill out a blank application to be provided by the Secretary, who shall present the same, when filled out, to the Board of Trustees, who shall examine the application, and if satisfied that the applicant is eligible, shall recommend him for membership at the same or next annual meeting. All applications shall be returned by the Board of Trustees to the Secretary. No application or nomination for membership shall be entertained by this Society unless endorsed by a majority of the Board of Trustees.

ELECTIONS.

SEC. 6. In elections for membership, members shall vote by ballot, and five or more ballots in the negative shall exclude an applicant from membership. No notice shall be made in the minutes of the Society of the non-election of any applicant.

SEC. 7. On being elected, the applicant shall sign the Constitution and By-Laws, and pay to the treasury an initiation fee of two dollars, after which he shall receive a certificate of membership. If the initiation fee be not paid within six months from notice of election, said election shall be considered void. All members shall sign the Constitution and By-Laws, and are entitled to a certificate of membership.

SEC. 8. Whenever any person is elected to active, associate, or honorary member, the Secretary shall immediately inform him thereof by letter. No person shall be an honorary member unless he signifies his acceptance of membership within six months from the election.

SEC. 9. Every person admitted to the Society shall be considered as belonging thereto, and liable for payment of all assessments until he shall have signified to the Treasurer his desire to withdraw; when, if the Secretary-Treasurer shall show that his dues have been fully paid up, he shall receive an honorable dismissal from the Board of Trustees.

Any member who shall neglect or refuse to pay any assessment for a period of six months, after due notice by the Treasurer has been given, shall cease to be a member. He may be reinstated again by the payment of the amount of the assessment standing against him.

SEC. 10. Any member may, for just cause, be expelled from the Society by a three-fourths vote. No public announcement shall be made of the fact.

DUES.

SEC. 11. The annual dues for active and associate members shall be three dollars, payable in advance at the beginning of each Society year.

ARTICLE IV.

OFFICERS.

SEC. 1. The officers of this Society shall be a President, a Vice-President, a Secretary-Treasurer, and a Board of Trustees of five members, all of whom shall be elected from the active membership of the Society, and who shall hold office for one year or until their successors are elected.

SEC. 2. They shall be elected on the second day of each annual meeting, and their term of office shall begin immediately after the closing of the annual meeting at which they are elected.

The Society year shall begin at the same time.

SEC. 3. The President shall preside at all meetings of the Society and shall call special meetings at the written request of five members. He shall sign all orders on the Treasurer, and all certificates of membership. In case of failure of appearance at any annual meeting of a quorum of the Board of Trustees, the President shall have power to supply such deficiencies by appointing temporary trustees for the transaction of the official work of such Board during such annual meeting.

He shall be ex-officio member of the Board of Trustees and of all committees, but shall have no vote on said Board and said committees.

The President, with the Secretary and the Board of Trustees, shall arrange the program of exercises for each annual meeting, and shall have general care over the affairs of the Society.

A nominating committee of three members shall be named by the President on the second day of each annual meeting.

SEC. 4. The Vice-President shall preside during the absence or at the request of the President. In case of absence of both, a President pro tem shall be elected. The Vice-President shall relieve the President and the Secretary-Treasurer of their official work from time to time as the President shall direct. He shall be an ex-officio member of the Board of Trustees, but shall have no vote in said Board.

SEC. 5. The Secretary-Treasurer shall keep an accurate record of the proceedings of the Society, and enter the same upon the journal when approved. He shall conduct the correspondence of the Society and make a minute of all such correspondence in a book to be provided for that purpose. He shall sign all certificates of membership, shall be an ex-officio member of the Board of Trustees, but shall have no vote in the Board; shall be the custodian of all the Society records; shall deliver all such records or other property of the Society in his possession to his successor, and shall make an annual report, and shall compile and edit the annual report of this Society.

He shall have charge of the funds of the Society and shall give bond with two approved sureties to such amount as may be required from time to time by the Board of Trustees; and his bond

when approved by the Board of Trustees, shall be copied on the journal of the Society and deposited with the President of the Society. He shall pay only such orders as have been signed by the President. He shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor.

SEC. 6. The Board of Trustees shall audit the accounts of the Treasurer and shall examine and report on all applications for membership and the honorable dismissal of members as provided for in Article III, Secs. 5 and 9, and will have a general care over the affairs of the Society as provided in Sec. 3 above.

The Board of Trustees shall provide a place of meeting and give at least twenty days' notice to the members of the Society.

STANDING COMMITTEES.

SEC 7. The President shall appoint at the beginning of each Society year six standing committees of five members each, whose duty it shall be during the year to collate such facts, figures, information and experiments of interest in their respective departments as may be brought to their notice, and make at least one formal report to the Society at the annual meeting following their appointment.

The committees shall be designated as follows and their reports made in the order fixed by the committee on program, viz.:

The Legislative Committee.
Committee on Public Highways.
Committee on Land Surveying and Drainage.
Committee on Civil, Mechanical and Electrical Engineering.
Committee on Instruments and Exhibits.
Committee on Applied Science and Architecture.

Each standing committee shall look after and be responsible to the Board of Trustees for the entire annual literary program under the title of said committee. The chairman of each standing committee shall confer with the chairman of the Board of Trustees as to the character of his particular literary work.

ARTICLE V.

SEC. 1. The Society may provide for the pay of any or all of its officers for their services, whenever deemed advisable.

ARTICLE VI.

SEC. 1. Whenever ten or more members shall signify in writing their desire to form a section of this Society for the advancement of a special branch of engineering, the Board of Trustees shall consider such application, and submit it with an expression of opinion to a regular meeting for a letter ballot.

The application shall be granted if two-thirds of the votes be in the affirmative.

Sec. 2. Such sections shall have the privilege of separate meetings for the reading of papers and discussions, at times and places to be determined by themselves, but may not assume to transact business in the name of the Society.

Sec. 3. The transactions of such sections shall be published by the Society under the usual regulations, but no expense other than for such publications shall be borne by the Society.

ARTICLE VII.

This constitution may be amended at any annual meeting by a two-thirds vote, but shall never be amended so as to be confined to the exclusive use and needs of any one branch of engineering.

BY-LAWS.

Section 1. The annual meetings of the Society shall be held in Columbus, Ohio, at any time to be fixed by the Board of Trustees.

Called meetings may be held at any place in Ohio; or any regular meeting may be held at any place other than Columbus, in Ohio, whenever a majority of the members attending the previous meeting may so determine.

Sec. 2. One-fourth of the regular members of this Society shall constitute a quorum.

Sec. 3. All resolutions shall be in writing.

Sec. 4. A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with the name of the donors, shall be entered by the Secretary in a book to be provided for that purpose.

Sec. 5. The Society may by a three-fourths vote go into secret session for the transaction of business.

Sec. 6. The parliamentary authority for this Society shall be "Roberts' Rules of Order."

Sec. 7. The By-Laws may be amended at any annual meeting by a two-thirds vote.

Sec. 8. No appropriation shall be made of this Society's money, other than for the ordinary current expenses of this Society, without a unanimous vote of the Board of Directors.

Sec. 9. Applications for membership at other times than at stated meetings of the Society shall be reported to the Board of Trustees during the interim, and on the favorable report of the Board of Trustees the President and Secretary shall be authorized to cast the ballot, and the Secretary shall notify the applicant of the result of said ballot.

Notice to Members.

It is desired to call the attention of the members to those who advertise in the pages of this report, and trust that they will patronize them if in need of anything in their respective lines. Kindly inform them of lettings in your vicinity, or furnish them with information at your command which may be of service to them. Advertisers are especially grateful for favors of this kind, and it is only just that we reciprocate. Advertisers help our Society by advertising with us, and you will greatly assist the officers of the Ohio Society of Surveyors and Civil Engineers by extending them these courtesies.

HONORARY MEMBERS.

Frost, George H.....Manager *Engineering News*..New York, N. Y.
154 Nassau St.
McFarland, R. W....Civil Engineer............Corning....Perry
Mendenhall, T. C....President.................Worcester, Mass.
Worcester Polytechnic Institute.
Thompson, Benj.....Civil Engineer............Chattanooga, Tenn.

ASSOCIATE MEMBERS.

Beckman, Louis......Manufacturer of...........Toledo.....Lucas
Engineering and Surveying Instruments.
Lucke, Chas. E.....Mgr. St. Louis Branch......St. Louis, Missouri
Keuffel & Esser Co. 708 Locust St.

STATE DIRECTORY

—OF—

Civil Engineers and Surveyors.

NOTE.—Names marked thus * are members of The Ohio Society of Surveyors and Civil Engineers.

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*Abernethy, C. F....City Engineer.............Circleville..Pickaway
*Alderdice, W.....‹.Civil Engineer............Warren....Trumbull
Alkire, H. F.........Surveyor..................Willia'sport.Pickaway
Ames, D. D..........Civil Engineer and Surv'or.BowlingG..Wood
*Amsden, Lewis A...Assistant City Engineer....Ashtabula..Ashtabula
Anderson, Arthur....Mining Engineer..........Athens....Athens
*Andrews, E. L......Civil Engineer.............Lima.......Allen
Archer, W...........Prin. Ass't Eng. B. & O. R'y.Cincinnati..Hamilton
Armocost, Eli........Civil Engineer.............Greenville..Darke
Arnett, J...........Civil Engineer and Surv'or.London.....Madison
Ashcraft, O. L.......County Surveyor..........Mt. Vernon.Knox
Asher, J. H..........County Surveyor..........London.....Madison
*Atkinson, J. W.....City Engineer.............Galion.....Crawford
*Ault, Edward S.....Civil Engineer and Surv'or.Marion.....Marion
Ayer, John..........Civil Engineer and Surv'or.Withams'le.Clermont

Babst, C. W.........City Engineer.............Crestline...Crawford
*Bachtell, Samuel....Assistant Engineer State...Columbus..Franklin
Board Public Works.

Baillie, Jno	County Surveyor	Shawnee	Perry
*Baird, E. C	County Surveyor	Dayton	Montgomery
Baker, F. R	Mining Engineer	Athens	Athens
Banks, George	Civil Engineer and Surv'or.	Sandusky	Erie
Barker, Frank M.	County Surveyor and City Engineer.	Painesville	Lake
Barnaby, Chas. L.	Ass't Eng. Cin. Division P. C. C. & St. L. R'y.	Cincinnati	Hamilton
Barr, James P	Civil Engineer and Surv'or.	Amanda	Fairfield
*Bartholomew, G. W.	Buckeye Port'd Cement Co.	Bellefont'e	Logan
Bartlett, Levi	County Surveyor	Marietta	Washington
Bashore, F. W	Civil Engineer and Surv'or.	Paulding	Paulding
Bashore, T. H. B.	Deputy County Surveyor	Paulding	Paulding
Baum, J. L	Civil Engineer and Surv'or.	Bournville	Ross
Baumer, J. H	Civil Engineer and Surv'or	Cincinnati N. W. cor. Third and Main sts.	Hamilton
Bayne, J	Assistant City Engineer Pavements.	Cleveland	Cuyahoga
Beach, D. P	Ass't Engineer Pa. R'y Co.	Wellsville	Columbiana
Beatty, J. G	City Engineer	Columbiana.	Columbiana
Beatty, L. R	Deputy County Surveyor	Van Wert	Van Wert
Beck, A. A	Deputy County Surveyor	Columbus	Franklin
*Beckman, Louis	Manufacturer of Engineering Instruments.	Toledo	Lucas
Beebe, S. D	Surveyor	Lakeside	Ottawa
Beers, John.	Civil Eng. and Principal Engineering School.	Greenville	Darke
Beightler, William P.	Surveyor	Marysville	Union
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Berbout, E. N	Civil Engineer and Surv'or.	Cleveland 153 Hanover St.	Cuyahoga
Bill, H. W	Civil Engineer and Surv'or.	Cleveland 87 Public Square.	Cuyahoga
Billings, B. F	Civil Engineer and Surv'or.	Blue Creek.	Adams
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Bird, S. Van	County Surveyor	Springfield	Clark
Birnbaum, A. P	Civil Engineer	Cincinnati 2735 Spring Grove Ave.	Hamilton
Blackford, Robt. S	Civil Engineer and Surv'or.	Columbus	Franklin
Blair, F. J	Civil Engineer and Surv'or.	Ashtabula	Ashtabula
Blinn, R. S	Architect and Civil Eng	Coshocton	Coshocton
Bloom, J. G	Div. Eng. B. & O. R'y Ohio Division.	Chillicothe	Ross
*Boalt, Eugene E.	Civil and Sanitary Eng	Cleveland 45 Outhwaite Ave.	Cuyahoga

Boarland, C. W	Civil Engineer and Surv'or.	Pleas'tville.	Fairfield
Boeh, Louis F	Civil Engineer	Cincinnati 4135 Florida Ave.	Hamilton
Boeh, W. H	Chief Engineer Cincinnati Water Works.	Cincinnati City Hall.	Hamilton
Bolton, Elmer C	City Engineer and County Surveyor.	Findlay	Hancock
***Bone, Frank A**	Engineer Oregonia Bridge Co.; U. S. Leveller.	Lebanon	Warren
Borst, C. H	Civil Engineer and Surv'or.	Akron	Summit
Borton, D. C	City Engineer	Massillon	Stark
Bouscaren, G	Civil Engineer Water Works Commission.	Cincinnati City Hall.	Hamilton
***Boughton, W. H**	Instructor in Mathematics Denison University.	Granville	Licking
Boustedt, Frank	Assistant City Engineer	Akron	Summit
***Bowen, B. F**	Civil Engineer	Columbus 226 E. State St.	Franklin
Bowen, F. C	Deputy County Surveyor	Marion	Marion
Bratt, Benj. F	Civil Engineer and Surv'or.	Portsmouth.	Scioto
Braun, Walter	Deputy County Surveyor	Columbus	Franklin
Breen, J. E	Ass't Eng. Board of P. S.	Cincinnati City Hall.	Hamilton
Brentlinger, E	Civil Engineer and Surv'or.	Dayton 1308 N. Main St.	Montgomery
Brett, Bert	Civil Engineer and Surv'or.	Geneva	Ashtabula
***Bretz, A. E**	County Surveyor	Lancaster	Fairfield
Brewer, I. C	Civil Engineer and Surv'or.	Sandusky	Erie
Breyman, Chas. H	Assistant City Engineer	Toledo	Lucas
Brinkerhoff, John	Civil Engineer and Surv'or.	Wooster	Wayne
Broomhall, Burt	Surveyor	Spencers	Guernsey
***Brown, C. N**	Prof. of Civil Engineering Ohio State University.	Columbus	Franklin
Brown, George	Draughtsman City Engineer's Office.	Toledo	Lucas
Brown, Hiram	Surveyor	Urbana	Champaign
Brown, J. A	City Engineer	Wilmington.	Clinton
Brown, Jay F	Civil Eng. and Contractor	Cleveland Cuyahoga Building.	Cuyahoga
Brown, J. R. C	Assistant City Engineer	Gallipolis	Gallia
Brown, W. F	City Engineer	Toledo	Lucas
Brumbaugh, W. D	City Engineer	Greenville	Darke
Brunch, F. F	Surveyor	Elyria	Lorain
Bryan, R. A	City Engineer	Portsmouth.	Scioto
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Buck, Thad. E	County Surveyor	Mt. Gilead	Morrow
Buell, C. W	Civil Engineer and Surv'or.	Toledo 2052 N. 14th St.	Lucas

Buell, James K	Surveyor	John'nville	Trumbull
*Burgess, Clarence H	Civil Eng. and Contractor	Cleveland	Cuyahoga
		89 Euclid Ave.	
Burke, M. D	Civil Engineer	Cincinnati	Hamilton
		404 Pike Bldg.	
Butler, J. H	County Surveyor	Peebles	Adams
Butts, W. H	Ass't Eng. B. & O. R'y	Cincinnati	Hamilton
Buxton, C	Chief Eng. T. & O. C. R'y	Toledo	Lucas
Cafferty, H. L. M	Civil Engineer and Surv'or	London	Madison
*Cantrell, G. W	Civil Engineer and Surv'or	S. Brooklyn	Cuyahoga
Carlisle, W. A	Civil Engineer	Coshocton	Coshocton
Carothers, D. D	Civil Engineer, Dept. M of W., B. & O. R'y.	Cincinnati	Hamilton
Carpenter, E. J	Assistant U. S. Engineer	Cincinnati	Hamilton
		Government Bldg.	
Carson, Irvin	Assistant City Engineer	Chillicothe	Ross
Carter, Wm. J	Ass't City Eng., Sewers	Cleveland	Cuyahoga
Cartwright, J. S	City Engineer	Ottawa	Putnam
Cassil, A	City Engineer	Mt. Vernon	Knox
Cassil, N. H	Civil Engineer	Mt. Vernon	Knox
*Cellarius, F. J	Assistant City Engineer	Dayton	Montgomery
		Room 8, City Bldg.	
Chamberlain, L. W	Civil Engineer and Surv'or	Marietta	Washington
Chamberlin, John R	Civil Engineer (at O. S. U.)	Tiffin	Seneca
Chapin, L. E	Civil Engineer	Canton	Stark
Chase, R. D	Civil Engineer and Surv'or	Sandusky	Erie
*Cobb, Fred	Civil Engineer	Akron	Summit
Cole, Glen G	County Surveyor	Holmesville	Holmes
Cole, J	County Surveyor	Ravenna	Portage
Collins, R. G	Civil Engineer	Zanesville	Muskingum
Conklin, Frank	Civil Engineer and Surv'or	P't Jeff'son	Shelby
Consaul, Frank I	Assistant City Engineer	Toledo	Lucas
Converse, H. J	Civil Engineer and Surv'or	Plain City	Madison
Conway, H. L	Ass't Eng. Water Works	Cincinnati	Hamilton
		2510 Hemlock St.	
Cook, J. D	Civil Engineer and Surv'or	Toledo	Lucas
		56 Law Bldg.	
Cooke, Edward C	Engineer Water Works	Cleveland	Cuyahoga
		822 Soc. for Sav. Bldg.	
Cor[illegible]mar, H. L	Ass't Eng. B. & O R'y	Zanesville	Muskingum
Cor[illegible]mar, T. C	Civil Engineer and Surv'or	Zanesville	Muskingum
Corns, H. C	Civil Engineer and Surv'or	Ironton	Lawrence
Correll, E. J	Ass't Eng. B. & O. R'y Ohio Division.	Chillicothe	Ross
Coryell, W. C	Civil Engineer and Surv'or	W. Union	Adams
Counts, Charles	Ex-County Surveyor	P't Jeff'son	Shelby
Cowen, Clinton	Surveyor	Cincinnati	Hamilton
		540 Main St.	

Buell, James K	Surveyor	John'nville	Trumbull
*Burgess, Clarence H	Civil Eng. and Contractor	Cleveland	Cuyahoga
		89 Euclid Ave.	
Burke, M. D	Civil Engineer	Cincinnati	Hamilton
		404 Pike Bldg.	
Butler, J. H	County Surveyor	Peebles	Adams
Butts, W. H	Ass't Eng. B. & O. R'y	Cincinnati	Hamilton
Buxton, C	Chief Eng. T. & O. C. R'y	Toledo	Lucas
Cafferty, H. L. M	Civil Engineer and Surv'or	London	Madison
*Cantrell, G. W	Civil Engineer and Surv'or	S. Brooklyn	Cuyahoga
Carlisle, W. A	Civil Engineer	Coshocton	Coshocton
Carothers, D. D	Civil Engineer, Dept. M of W., B. & O. R'y.	Cincinnati	Hamilton
Carpenter, E. J	Assistant U. S. Engineer	Cincinnati	Hamilton
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Carson, Irvin	Assistant City Engineer	Chillicothe	Ross
Carter, Wm. J	Ass't City Eng., Sewers	Cleveland	Cuyahoga
Cartwright, J. S	City Engineer	Ottawa	Putnam
Cassil, A	City Engineer	Mt. Vernon	Knox
Cassil, N. H	Civil Engineer	Mt. Vernon	Knox
*Cellarius, F. J	Assistant City Engineer	Dayton	Montgomery
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Chamberlin, John R	Civil Engineer (at O. S. U.)	Tiffin	Seneca
Chapin, L. E	Civil Engineer	Canton	Stark
Chase, R. D	Civil Engineer and Surv'or	Sandusky	Erie
Cobb, Fred	Civil Engineer	Akron	Summit
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Collins, R. G	Civil Engineer	Zanesville	Muskingum
Conklin, Frank	Civil Engineer and Surv'or	P't Jeff'son	Shelby
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Cooke, Edward C	Engineer Water Works	Cleveland	Cuyahoga
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Corns, H. C	Civil Engineer and Surv'or	Ironton	Lawrence
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Coryell, W. C	Civil Engineer and Surv'or	W. Union	Adams
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Cowen, Clinton	Surveyor	Cincinnati	Hamilton
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***Cronley, J. C**	County Surveyor and Civil Engineer.	Lima	Allen
Cully, Fred S	County Surveyor	Newark	Licking
Cully, John L	Civil Engineer	Clevelnnd, 33 Blackstone Bldg.	Cuyahoga
Curfman, Samuel	City Engineer	Steub'ville	Jefferson
Curtis, L. G	Dept. M. of W., B & O. R'y.	Zanesville	Muskingum
Danenhower, C. N	Civil Engineer.	Cincinnati, 1215 Jackson St.	Hamilton
Danford, B	County Surveyor	Whigville	Noble
Darst, B. F	Civil Engineer and Surv'or.	Shoups Sta.	Greene
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***Davis, Chas. S**	Civil Engineer and Surv'or.	Toledo	Lucas
***Davis, Jno. B**	Civil Engineer and Surv'or.	Cleveland, 242 The Arcade.	Cuyahoga
Davis, J. C.	Civil Engineer and Surv'or.	Cleveland	Cuyahoga
Davis, J. D.	Ex-County Surveyor.	Chest'r Hill	Morgan
Davis, M. L	Civil Engineer	Lisbon	Columbiana
Davis, Solon	Civil Engineer and Surv'or.	Weston	Wood
Davis, W. L	Civil Engineer and Surv'or.	Ironton	Lawrence
***Davisson, F. M**	Civil Engineer and Surv'or.	W. Manch'r.	Preble
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***DeMotte, R. K**	County Surveyor and Civil Engineer.	Eaton	Preble
***Denison, L. B.**	Civil Engineer and Surv'or.	Delaware	Delaware
Dennick, Ed	Draftsman, Mt. Vernon Bridge Co.	Mt. Vernon	Knox
Dercum, Otto	Civil Engineer and Surv'or.	Cleveland, 362 Sibley St.	Cuyahoga
Derrickson, Geo. M	Civil Engineer and Surv'or.	Akron	Summit
Devereux, H	Resident Eng. B. & O. R'y	Cincinnati	Hamilton
Devore, L. N	Engineer Bellefontaine Bridge Co.	Bellef'taine	Logan
Dick, H. B	Chief Eng. P. & L. K. R'y	Zanesville	Muskingum
Dickens, E.	Civil Engineer and Surv'or.	Pedro	Lawrence
***Dickey, E. P**	City Engineer	Warren	Trumbull
Dickinson, L. A	City Engineer and Surv'or.	Fremont	Sandusky
Diemar, C. R	County Surveyor.	Ironton	Lawrence
Dike, J. S	Deputy County Surveyor	Delaware	Delaware

*Dillon, L. A.	County Surveyor and City Engineer.	Hamilton	Butler
Dimock, E. W	Civil Engineer and Surv'or.	Dupont	Putnam
Dixon, J. R.	Civil Engineer and Surv'or.	Orwell	Ashtabula
Doak, A. S.	County Surveyor	Winchester.	Adams
Doane, L. W.	Civil Engineer and Surv'or.	Zanesville	Muskingum
Donham, David	Civil Engineer and Surv'or.	Lindale	Clermont
Donnelly, J. F.	Deputy County Surveyor	Montpelier	Williams
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Doty, Geo	Civil Engineer and Surv'or.	Edon	Williams
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*Dowler, J. W	County Surveyor	Troy	Miami
Dowling, Jos. L.	Civil Engineer Buckeye Pipe Line Co.	Lima	Allen
Dowson, W. C	Civil Engineer	Cincinnati, 2617 Cleinview Ave.	Hamilton
Dumm, R. R.	Ex-County Surveyor.	Wharton	Wyandot
Dunn, J. J.	Civil Engineer	Columbus	Franklin
*Dunn, Wm	County Surveyor	Zanesville	Muskingum
Dwyer, Geo. H.	Assistant City Engineer	Marion	Marion
Earnshaw, Joseph	Civil Engineer and Surv'or	Cincinnati, Glenn Bldg.	Hamilton
Eberhard, Julius	City Engineer	Wooster	Wayne
Edwards, E. M.	Civil Engineer and Surv'or.	Cleveland, 1309 Cedar Ave.	Cuyahoga
Egerton, J. T.	County Surveyor	Ironton	Lawrence
Eldridge, Wm.	Surveyor	Bartlett	Washington
Eldridge, J. J	Surveyor	Bartlett	Washington
Ellis, Jeremiah.	(From Adams Co., O.)	Concord, Ky.	
Ells, Wm. B	Civil Engineer	Mt. Gilead	Morrow
English, D. H	Surveyor	Defiance	Defiance
Engle, Robert L.	Civil Engineer and Surv'or.	Cincinnati, 1530 Lincoln Ave.	Hamilton
Eno, Frank H.	Ch. Draughtsman Dep. Pub. Imp.	Columbus	Franklin
Estep, E. J.	Ass't City Eng., Surveys	Cleveland	Cuyahoga
*Evers, Wm. H.	County Surveyor	Cleveland	Cuyahoga
Faist, J. E.	Civil Engineer	Hamilton	Butler
Farmer, I. P.	Ex-County Surveyor.	Lisbon	Columbiana
Farbell, J. D.	Civil Engineer and Surv'or.	Bedford	Cuyahoga
Fauver, Lester.	County Surveyor	Elyria	Lorain
Fawcett, Joseph	Civil Engineer	Carrollton	Carroll
Fawcett, John	Civil Engineer	Kilgore	Carroll
Fawcett, Oscar	Surveyor	Walnut Grove,	Logan
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Fox, Al	Civil Engineer and Surv'or.	Brookville	Montgomery
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Fox & Goodspeed	Mining Engineers	Nelsonville.	Athens
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Franklin, Byron	County Surveyor	Wilmington.	Clinton
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Fullerton, A. L	Architect and Civil Engin'r.	Chillicothe	Ross
Galvin, Archie J	Ass't City Engineer	Cleveland	Cuyahoga
		128 Franklin Ave.	
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Garrett, George M	Civil Engineer and Surv'or.	Cleveland	Cuyahoga
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Gault, Homer J	Civil Engineer and Surv'or.	Cleveland	Cuyahoga
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Giessen, Charles H...Civil Engineer and Surv'or.Cleveland ..Cuyahoga
20 Blackstone Bldg.
Gilbert, ——.........Surveyor..........Venice, Ross P. O...Butler
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*Gilpatrick, J. L.....Prof. of Civil Engineering..Granville...Licking
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Ginn, W. A..........County Surveyor ....Bellefontaine, Logan
Glasgow, W. R.......Civil Engineer and Surv'or.Shiloh......Richland
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Goldfogle, David.....Civil Engineer. ....Cincinnati..Hamilton
Dennison Hotel.
Good, Charles W. B..Assistant Engineer.........Ashland ...Ashland
Good, Emery H......Deputy County Surveyor...Tiffin..... .Seneca
Goodell, R. S ....Prin. Ass't Engineer.......Mt. Vernon.Knox
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Graham, E. E........Draut'sman Morgan En. Co. Alliance....Stark
Graham, Alva . .....Surveyor ....Marysville..Union
Greek, Jacob ....City Engineer ....Upper Sandusky..Wyandot
Griffin, O. U.........Civil Engineer and Surv'or.Fayette.....Fulton
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Dep. Public Improvements.
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*Groves, John W....Eng. Sunday Creek Coal Co.Corning....Perry
*Gyer, George R.....Civil Engineer and Surv'or.Alliance....Stark

*Hanlon, John A ....City Engineer ....Coshocton..Coshocton
*Hanlon, Wm. B.....Chief Engineer............Cleveland ..Cuyahoga
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Harrison, B. W......County Surveyor ....Cincinnati..Hamilton
Court House.
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*Harvey, Lanson B ..Civil Engineer and Surv'or.Marysville..Union
*Haseltine, Edwin D.Civil Engineer and Surv'or.Youngsto'n.Mahoning
Haseltine, Robt. M...Civil Engineer and Surv'or.Youngsto'n.Manoning

Hatcher, John D.....Civil Engineer and Surv'or.Forest Dale.Lawrence
Hatcher, W. B. G....Civil Engineer and Surv'or.Sheridan ...Lawrence
Coal Works.
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Henretta, C. M ......Mining Engineer ....Cambridge..Guernsey
Hewitt, B. F........ Civil Engineer and Surv'or.Conneaut...Ashtabula
Heyl Brothers.......Surveyors ....Cincinnati..Hamilton
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Hibbs, Wm..........Mining Engineer .... Scio ....Harrison
*Hill, Geo. H........Civil Engineer and Surv'or.Milford.....Clermont
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33 Wiggin's Block.
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25 The Nasby.

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Wulfekoetter, E. W., Jr.	Surveyor	Cincinnati 14 Hulbert Block.	Hamilton

Ohio Society of Surveyors and Civil Engineers

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President's Address.

A. W. JONES, COLUMBUS.

It is customary when a person is unexpectedly called upon to make a speech, or is compelled to make a speech without time to prepare, that he should make apology and give excuses to his audience. I have been overwhelmed with work and no time to prepare, but nevertheless I will not make apologies to my audience, as it is composed of fellow members of the society. On the contrary, the members of the society should apologize to me for taking an unfair advantage in electing me to this office while I was absent from last year's meeting. One advantage is with me, though, for my first training in school was not that of an engineer, and for years I studied that I might become a preacher or a lawyer, consequently learned to talk when there was nothing to say or merely to kill time. Very well I remember our debating society, and a certain evening when myself and a class-mate were to choose sides and debate, first casting lots for who should be affirmative and who should be negative. The affirmative speaker was to take the floor, and the professor of mathematics was to hand him a sealed envelope containing the question for debate. Fortune seemed with me, for I won choice and, of course, took the negative. My opponent took the floor and the question was handed to him. He slowly opened the envelope and read, "Would the world and the people thereof be better off if every one attended strictly to his own business?" At first glance, the negative looked bad; so thought my opponent, and spoke thinking he had fully convinced the judges and the audience of the fact. A few minutes later the affirmative saw that there was a negative side to the question, and an hour and a half later the unanimous opinion of the judges was that the negative had won the debate. I am still fully convinced both from argument and experience that the people in this world are not better off if they are always attending strictly to their own business. I was attending to my own business last winter when you elected me to an office, which by custom requires an address, and for a week I have been trying to think of something to say which has not been said many times before. Several times and from various standpoints, we have had the progress of engineering reviewed, and it would be useless for me to attempt to improve on the papers you have heretofore heard, and I shall only give you a few random thoughts, presented in a

rambling manner that may call you to reflect a little upon the past and day-dream as to the future.

When at the Ohio State University sixteen or seventeen years ago, we thought we had a splendid school of engineering and that we would leave well prepared for the duties of an engineer. When we visit the institution now and see how thoroughly the department is equipped, and how much more complete the course in engineering has become, and how much more is required of the students, we can but feel that when the present students graduate they will be started in the profession far ahead of where we started. We can now feel sure that an Ohio boy can without leaving the State get a splendid preparation as an engineer — civil, mining, mechanical or electrical, — and we all take a just pride in the fact that our State has so well equipped and is constantly adding to the equipment and facilities for instruction at the State University. There is one consolation, though, to those of us who attended ten or twenty years ago or never took the course at all, for we remember that "Engineers are born, not made," and we have been long enough at work to know whether we are engineers, or whether we had better quit and go to preaching, plowing corn or running a saloon, as there is something that fits every kind of a man. Well do I remember the first few years after beginning work, how I wished that I were older and could have begun work about 1870, before the country was covered with railroads and the many great bridges erected. It seemed that the opportunities for a young engineer were so few, that companies were looking for men who had helped in building the great railroads and bridges of the decade before, that the great changes in development were past, that the country was old enough to advance only with slow and gradual growth, and that the engineer, like the carpenter or blacksmith, must settle down and become a satisfied plodder to do the regular work of each day. I know now that this was a mistake — that the greatest opportunities were yet to come and are coming. Although the most practical of men, and trained to handle things in the most practical manner, the engineer is and must be also a good deal of a dreamer and given to thoughts of great things in the future, that he may strive to bring them about. Some of the greatest problems that ever confronted the engineer are now before him, and he must assume responsibility in proportion to the progress of the age. The field of the engineer is becoming broader each year, the opportunities more plentiful and the requirements more exacting. The engineer of to-day must unhesitatingly undertake and successfully solve the greatest problems.

In every line of work with which the civil engineer has to deal there must be great advancement. Efficiency and economy must go together. The transportation question is probably the

greatest with which the engineer must deal. The public demands frequent, quick and safe transportation of passengers, and quick and cheap transportation of freight. The engineer must solve the problem and provide what is required. The old established roads are constantly reducing grades and bettering track, and improving in every way for cheap transportation. The best railroads in the country recognize the fact that a well trained and capable engineer, who knows a railroad from the time the first surveyor's stake is set until it is a complete and fully equipped trunk line, who learns it in every department as he grows with it, is the man to fill the higher offices in the management. Considering the number of men in the engineering department on railroads, more of the higher officers are advanced from this department than from any other. The young civil engineer who starts out and thoroughly learns a railroad has before him an excellent opportunity to attain high executive position, and if his ambition does not lead to this, a certainty of regular, remunerative and pleasant employment. Within the last few years, the transportation problem has assumed a new phase, which has started a phenomenal development of electric roads. It has been but a few years since there were no electric roads except in the cities. In places, these were extended a few miles to surrounding villages, and later, venturesome capitalists built some longer interurban roads in places where all steam railroad men said they would be flat failures. The results were surprising: on poorly built and poorly equipped roads, in territory well served by the best steam roads, a large and constantly growing traffic was carried, at a low cost and with good profit. The result has been an exceedingly rapid development of electric lines. In building and handling these roads, the civil and electrical engineer has practically a monopoly. These roads are becoming so common and so many are built in territory where the concentrated population is small, that all conditions must be carefully considered and compared by thoroughly trained engineers, or the results in the near future will be disastrous. These roads, well and correctly located and built in the first place, will be low in operating expenses and a safe and paying investment to the builders. In the above mentioned fields, the traveling public and the investors of countless millions look to the engineer for their protection.

The commercial world now looks to the civil engineer to solve and carry to a successful conclusion the construction of a practicable isthmian canal. The people of the United States are now practically a unit in favoring this enterprise, and the engineering profession is eager to undertake it, and confident of its successful termination. We look forward to the completion of this canal, the most gigantic engineering undertaking of a century, by the energetic and resourceful American engineer.

The rapidly increasing population of our great cities multiplies the difficulties and responsibilities of the members of our profession, who have to deal with municipal and sanitary work. Upon a pure, wholesome and abundant supply of water depends the health and safety of the urban inhabitant, and the maintenance of his health is dependent upon proper sanitary sewerage. For the proper conduct of his business and his safety in pleasure driving, he must have streets well paved and maintained. Under the most adverse circumstances, the engineer must solve these problems. He has over him the higher municipal officers elected because of political beliefs, possibly because they are for or against the Boer war, or for or against something equally foreign to our material safety and enjoyment of life. Frequently, these officers care but little and know much less of the needs of the departments that handle such vitally important questions, and the qualifications and abilities of their engineers is not questioned, if the said engineers have the proper opinion on the Boer war or the Philippine question. A few cities started on the right path years ago, and have well-designed, well-built municipal works that do not burden them with taxes. Mr. Benzenberg was City Engineer of Milwaukee for over twenty-five years. He had the confidence and respect of all the people. He was given authority and responsibility that few engineers receive or enjoy. Different administrations came and went. His department remained undisturbed, no one asked or cared as to his politics, his control was undisturbed, and the city has the benefit for all time of his splendid work. After long service, when he wished to resign and engage in private practice where the duties were not so arudous, the city was loath to accept his resignation. In opposition to this is San Francisco, where political engineers held sway for many years, and millions of dollars were expended in work that afterwards proved imperfect and useless. On a smaller scale, this has happened all over the country, but municipalities are gradually awakening to the importance of keeping the engineering department out of politics. In all larger cities, there is usually years of mismanagement back of this change, leaving a great bonded indebtedness, useless, half finished or incomplete works, and the problem for the municipal engineer of to-day is large and weighty, and his burden is surely "the white man's burden." In roads and public highways, there is a problem for the engineer and it is more than an engineering problem. The system of maintaining highways is so imperfect and wasteful that any corporation so spending its money would be landed in bankruptcy. Engineers must agitate the question and show up our lack of system until some time in the future laws may be passed that will start for us a system that will give the tax-payer value received for money paid out. Rural free delivery is making good roads more important than ever, and if the money spent in Ohio for roads was

expended with the care, wisdom and economy with which a railroad expends its money for repairs, we would in a few years have in Ohio a magnificent system of highways. Some legislation on the subject is necessary, and it is to be hoped that some time in the near future we may have a Governor who will recognize the need and make a recommendation to the legislature.

Another broad field which is opening for the engineers, is that of irrigation in the arid sections of the great west. Our rapidly increasing population must have more land and it is only a matter of a short time until the government must on a large scale store up water supplied by the melting snows on the great mountain ranges to use at the proper time and in large quantities for the irrigation of these vast tracts of rich soil, now almost entirely unproductive on account of insufficient rainfall.

These problems and many others of equal importance will be for the engineer to solve. He has before him a promising field, but a field in which there is no royal road to fame. His work must begin early and continue until late, and be almost without intermission or vacation, but he is assured of being in the van of progress and advancement.

Asphalt Repairs at Columbus, O., During the Year 1901.

BY E. A. KEMMLER.

The best plan for maintaining asphalt streets has not been invented yet. But it can be stated in a general way that the plan which permits the least time to elapse between the formation of a hole and the repair of the same, is the one which appeals most strongly to the public, and while not necessarily the most economical, ought to be adopted in all cases, if for no other reason than that of civic pride.

The plan of placing asphalt streets under maintenance contracts for a term of 5 to 10 years after the expiration of the guaranty seems to have given the best satisfaction from the point of view of efficiency, but the cost has been greatly in excess of that under the plan of payment for actual yardage repaired. For instance at Omaha, under 10 year maintenance plan the cost has been $.08 per square yard maintained per annum, while at Buffalo which city has been the object of slanderous attacks by certain opponents of asphalt paving, repaired its streets in 1895 for 6.7 cents per square yard; in '96-4.4 cents; '97-4.8 cents; '98-2.9 cents, and '99-3.1 cents.

Again, at Cincinnati the cost has been 7.5 cents during the first five years out of guaranty, and 14 cents during the second five years, while at Columbus, we have crowded 6.6 years of repairs into the past year, for a total of 12 cents per square yard.

St. Louis has had a municipal plant for a number of years, but is about to relegate it to the past, and do by contract for $18,000 per annum what it has cost the city about $11,000 to do heretofore. Detroit has recently contracted for the erection of a municipal plant, but the same has not been installed as yet, so that information as to municipal ownership is as yet very scant.

Repairs were made in Columbus during the past year under three different classes of contracts; namely:

Repairs under 10 year guarantee; One year maintenance by lump contract, Repairs per square yard under 5 year guaranty.

It is with the last named class that this paper has to deal.

The repairs were made by the Barber Asphalt Company, and the Cleveland Trinidad Company. 11.32 miles of street embracing 247,205 square yards of total surface, were repaired under these contracts.

Every patch was accuratelv located and platted in a note book, from which it was transferred to tracings, to a scale of 10 feet to an inch, and blue-print was made for reference etc. A copy of the blue-print was transmitted to each company for their use. It is the purpose to notify the contractors annually to look over their work and make the necessary repairs, and all defective work found by subsequent repairs will be charged to them and the cost deducted from the amount (10% of their contract) due them.

The sheets 20 x 30 inches in size, form a book of 88 pages.

The work of inspection, locating and platting was performed by four rod-men, receiving $2.00 and $2.50 per day. The total cost amounted to $1081, which was 3.5% of the total cost of the work, $31,204.80.

All water, gas and sewer cuts were charged to the respective companies.

The cost per square yard of repairs was $1.23 and $1.47.

Average age of street repaired 11.64 years, or 6.64 years out of guaranty.

Percent of total area repaired 8.31.

Cost per square yard of total area 12 cents.

This figure is expected to be cut in two next year, under similar treatment of the work.

One feature of the work was both interesting and important and that is the amount of repairs in the gutters. The average width of the street repaired was 31.4 feet. Within a strip of four feet on each side, along the curb, the area of which is 25.5% of the total, the repairs made were 63.3% of the total,

which is equal to an entirely new gutter, four feet wide, for 20.4% of the entire length. Two streets with a total area repaired of 1612 square yards, required 35 square yards outside of the gutter.

This large excess of wear and disintegration is, as is well known, attributed mainly to water which is not carried away in the gutter as fast as it falls, and to a smaller extent by the stamping of hitched horses. The remedy which has been adopted in many western and central cities is the combination of vitrified brick and asphalt, in which the gutters are of brick, and 3 to 4 feet wide.

A peculiar phenomenon was observed on two Kentucky Rock asphalt streets, laid on concrete without an intermediate binder or cushion course.

Ridges 3 to 6 inches high and 2 to four feet wide, had appeared, running straight across the street, at intervals of 2 to 300 feet, separating no doubt each day's work of concreting.

When the asphalt was removed it was found that the concrete had been crushed to pieces, and no trace of any bond was left.

Although this phenomenon was no doubt caused by expansion (the work was done in November and December) I am unable to explain why it should be confined to these two streets, the only rock asphalt streets in the city.

The repair work was done under a special law, enabling the city to borrow the necessary funds to meet the monthly estimates, and after the completion of the work, recover the money expended by an assessment per foot front on the streets repaired, with no rebate for corner lots.

The street plats have been very useful in settling disputes and complaints made by abutting owners, who sometimes claimed that no work, or very little was done on their street, sometimes asking simply how much and where it was done, so that they might know just what they are asked to pay for. The plats will also prove useful in future years, to show that the old work, and not the new patches, is wearing out. The popular mind can find no other explanation for the appearance of holes after a street has been patched, than that the repairs were badly made, and are going to pieces, the Engineering department is to blame, is incompetent, the Board of Public Works winked at this incompetency, and the whole city government is corrupt. The plats will nail such terrible conclusions without fear or favor.

The plats, if properly kept up from year to year, will also prove valuable as a basis for accurate estimates of the cost of making the repairs under lump contracts for five or ten years, or for furnishing data for an estimate of the cost and maintenance of a municipal plant. [Applause.]

THE CHAIR: Are there any questions which anyone would like to ask Mr. Kemmler, or any discussion of the paper?

MR. NIEDERHEISER: The gentleman spoke of Kentucky or rock asphalt streets: I would like to know how they compare with ordinary sheet asphalt?

MR. KEMMLER: Ours have been down, I think, either ten or eleven years and at first they were very soft, and one could take an umbrella and stick it into the concrete without any trouble. Horses' calks also sunk into it and made quite an impression. But after these streets had been down a year or two they hardened and have given about as good satisfaction as any streets we have; in fact, they have required less repairs than any Trinidad asphalt streets.

PROFESSOR GILPATRICK: Have you found any reason for the bulging in the street?

MR. KEMMLER: I attributed it to expansion. The streets were completed in the winter, and the ridges did not form until a year or two later.

PROFESSOR GILPATRICK: If laid at any other season is there any trouble?

MR. KEMMLER: We have none laid at any other season. These mentioned are the only ones we have and they were laid at the same time. No such phenomenon has occured on any other street in the city. The ridges formed just at the point where work was stopped one day and commenced the next, and there must be some force there to crush that concrete and raise the wearing surface above.

THE CHAIR: Did the concrete follow the wearing surface?

MR. KEMMLER: No.

THE CHAIR: With a vacancy between?

MR. KEMMLER: No; only as a mass of broken stone and sand.

THE CHAIR: Quite frequently in brick pavements there will be a little arch.

MR. KEMMLER: In this case, the wearing surface was carried up by the concrete underneath.

Designing of Riveted Connections.

BY PROFESSOR W. H. BOUGHTON, GRANVILLE.

INTRODUCTORY.

1. It is not the purpose of this article to teach how to design all sorts of riveted connections. Neither is it expected that current practice will be revolutionized by the results of this investigation. But the intention is to illustrate and emphasize the most essential qualification of the successful engineer, namely, good judgment. The laity regard mathematics and mechanics as the first prerequisite of the engineer, but the members of the profession know better. While they prize these sciences and appreciate fully the value of all the theoretical training in their application, they know too that the most eminent mathematician in the world would not make an engineer unless he had with his mathematics some natural sense of the fitness of things. And the most eminent physicist, who could explain all the mysteries of the vortex theory of matter could not build a bridge, a sewerage system or a locomotive unless he were familiar also with the ordinary *material* matter that common people deal with. The successful engineer is the one who sees all the elements of a problem, including the undetermined and indeterminate ones, gives to each its proper weight, makes reasonable allowances for the uncertain ones and comes to a prompt and proper decision.

In some departments of engineering, the proposition that a good judgment is the prime prerequisite, is almost an axiom. In bridge and structural work the mathematical calculations are so prominent that the truth of the proposition is sometimes lost sight of. It is hoped that a study of a few of the everyday problems of the detailing room will make the truth more prominent.

A RIVETED SPLICE.

2. For the first problem let it be required to splice a bar having a section 3″x½″ and subjected to tension. To avoid an eccentric pull the splice will be made of two bars each 3″ wide

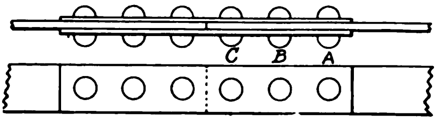


Fig. 1

and at least ¼″ thick so that the aggregate section is at least equal to the section of the bar spliced. To find the necessary number of rivets, divide the tensile stress in the bar by the shear-

ing value of one rivet or its bearing value in a ½" plate, whichever is less. Suppose three ⅞" rivets are required. They will have to be spaced in a single row along the axis of the bar as in figure 1.

This splice has been figured in the customary way, on the assumption that the tensile stress of the bar is uniformly distributed to the three rivets.

3. But let us examine whether this assumption can be true. If the bar transfers one third of its stress to the splice bars at and by means of rivet "A" and another third at and by means of rivet "B," then between A and B the stress in the main bar is twice the stress in the combined splice bars. Since the main bar and the splice have the same section, the main bar will stretch twice as much as the splice between A and B. That is, the distance between rivet centers is greater in the bar than in the splice. If these distances are unequal, the rivets are experiencing unequal distortions and that means that they are subject to unequal stresses. By beginning at the center of the splice and working toward the end, we find similar inequality between stresses in C and B. Then instead of the assumed condition of affairs we have rivet A and the splice from A to B carrying somewhat more than one third the stress in the main bar and the bar from A to B carrying somewhat less than two thirds the main bar stress; the rivet C and the main bar from C to B carrying somewhat more than one third the main bar stress and the splice from C to B carrying somewhat less than two thirds the same stress; rivet B carrying less than one third the same stress.

4. If two rivets were sufficient instead of three and the sections were the same as before, the difficulty would disappear but with three or more rivets, the end one and the one next to middle of the splice must carry greater loads than the others. Indeed, it will make this truth almost self-evident if a case is imagined where a large number of rivets is required, say 25. Imagine now some material used which stretches much more easily than steel and it will be evident that a few rivets at the middle of the splice and a few at the end will carry practically all the load.

5. In splicing a wide bar the rivets will be disposed in rows across the bar and arranged so as to keep the net section as large as possible, basing the arrangement on the assumption that the rivets bear equal portions of load. An investigation like the one just finished will show that the assumption is not true here either.

6. Do these facts call for a revision of the method of designing splices? The writer thinks not for the following reasons.

(a) Dividing the total stress by the value of one rivet usually gives a fractional quotient and the next higher whole number is taken as the number of rivets. This gives some excess of assumed strength.

(b) The safe working intensities of stress are assumed in accordance with the engineer's judgment, and, being assumed, they are taken in round numbers and well within the bounds of safety. If then some rivets have a little higher intensity of stress than that assumed, no harm will result.

(c) Friction relieves the rivets to some extent. This is more fully discussed in connection with another problem. See Art. 28 (b).

(d) Any working assumption as to distribution of load among the rivets may be entirely upset by the workmanship. If a rivet does not have bearing on the bars at points where stress is transmitted, it will carry no load till the bars stretch to it and then it will carry less than other rivets. When dealing with a material whose coefficient of elasticity is 29000000, a very small distortion corresponds to a large stress. The errors due to poor workmanship are or may be larger than those due to the fundamental assumption, hence there is no necessity for making that assumption any more refined.

A GUSSET PLATE CONNECTION.

7. Figure 2 is taken from the detail drawings of a roof recently built. It is drawn to scale but the dimensions are

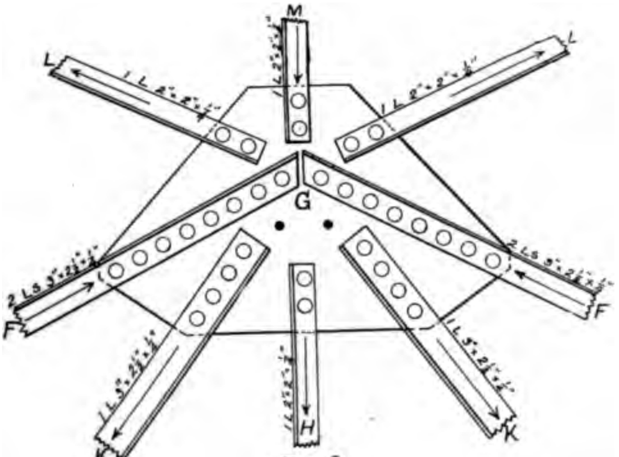


Fig. 2.

omitted. The connection occurs at the ridge of the main roof truss and the members GL, GM constitute parts of a ventilator truss attached to the main truss and spanning two panels of

the main truss at the ridge. The arrows show the directions of stresses with reference to the intersection point G.

8. Besides the features considered in the simple splice, this case presents several new ones. In the first place, all the members except the main rafters connect to one side only of the plate. This makes an eccentric pull on each one which tends to make an opening between it and the plate and to that extent to cause tension and bending in the rivets. The damage done, if any, is least in GK which has the longest row of rivets. In the others, having only two rivets, the full strength of two rivets is not needed to transmit the direct stress in the members, and the excess of strength doubtless provides for this case and the next to be mentioned.

9. As these members are angles connected by one leg only, they have bending moments to resist, and these moments increase and change the direction of the stresses in the rivets. The amount of these moments can be calculated if desired, but to find the additional stresses in the rivets requires the introduction of another assumption, which, under the circumstances, can be only approximate. If this item is important enough to consider, it will be better to eliminate it by connecting the other leg to the plate by an angle clip. But where the stresses are small it is easier to put in an extra rivet in one leg and it sometimes saves material and labor to do so.

In GF, the top panel of main rafter here shown, there would have been a gain in efficiency and compactness by connecting both legs of the angles to the plate, but in the few other places on the truss where there would have been such an advantage it was not possible to make the connection in that way, so the same system was followed throughout.

10. It is a common and a good general rule to make the connection as strong as the member connected. But connections should not always be judged by this rule. Frequently a member whose strength is much in excess of requirements is used, either as a result of carrying the same size continuously through several panels, or it is the minimum size that will take the rivets used on the job, or it is a size in stock, or for other reasons. In such cases it is not always necessary to observe the general rule.

11. A rule that can nearly always be followed is to make the directions of the forces intersect at figure points of the truss. In case of angles connected by one leg only as in the figure it is immaterial whether the center of gravity line or the gage line be taken as the line of force. In either case the same amount of moment is thrown on the plate to produce secondary stress in the truss.

12. The distribution of stress among the rivets of one member will be influenced by the shape of the plate, the nearness of other connecting members and the way stress is transmitted

through the plate. This case is then very much more complicated than the simple splice. It must be as true here as there that stress in a member is not equally divided among the rivets, but also it is here equally impossible to find any better rule for use than to assume an equal distribution. It might be added to the rule that the detailer is not to use rivets with too parsimonious frugality, or, as it is heard in the drafting room. "Put in enough."

REINFORCING PLATES.

13. The plates riveted to the webs of I beams and channels in order to increase the bearing area against pins are assumed to divide the pressure with the webs in the ratio of their thicknesses and the rivets are calculated on this basis. The chief uncertainty here lies in our ignorance of how the pressure received by the web directly from the pin and that received indirectly through the rivets is distributed over the whole cross section of the web and the flanges. When the pin is placed at the center of the depth of channels which have a cover plate on one side only there is further uncertainty on account of the eccentricity thus introduced. When reinforcing plates are placed on one side only of the web, the rivets doubtless act less efficiently than otherwise. Again, a rough calculation based on a detailed design showed that the shearing distortion of the rivets was greater than the compressive distortion of the web due to the shares of load they were assumed to carry. This happens largely because the coefficient of elasticity is so much less for shearing than for compression.

14. All the uncertainties mentioned for this case tend to increase the amount of pressure taken directly by the web and it seems quite probable that this is the usual condition. But the reinforcing plates stiffen the web against local buckling so that no harm follows.

MISCELLANEOUS CONNECTIONS.

15. In this section will be mentioned without minute discussion several varieties of connections which, because of some peculiarity, are not always wholly determinate. Such are batten plates used with latticing, knee braces, sway rod connections on trestles and piers, and on roof trusses and some forms of lateral connections on bridges.

16. In some of these cases a theoretically good design can usually be secured but in others it is seldom possible to get one free from objection. The difficulty comes from the location of the connection or the duty to be performed by the members connected. A moment is thrown on the connection, causing unequal stresses in the rivets and sometimes subjecting them to tension.

17. In all the cases enumerated, the stresses in the members connected are to some extent uncertain, so that it is not neces-

sary to use very refined methods in calculaing the connection. Usually it will be best to use the ordinary approximation and make a liberal allowance for contingencies.

BEAM CONNECTIONS.

18. The last problem to be considered will be that of connecting beams to their supports when they are held by angles riveted to their webs. In this problem the great frequency with which the same case recurs makes it worth while to study the problem pretty carefully. Figure 3 represents one beam attached to another by standard connection angles.

If the riveted connection possessed the same rigidity against deflections as the beam itself and the beam were simply supported

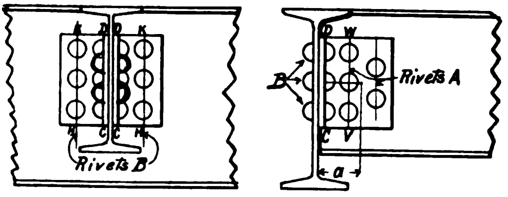


Fig. 3.

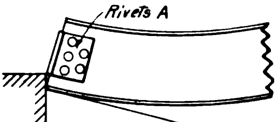


Fig. 4.

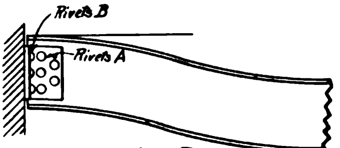


Fig. 5.

at the back of angles, then the deflection would be as shown by figure 4. But if the angles are riveted rigidly to the support, the beam will be "fixed at end" and will deflect as shown by figure 5.

In the first case rivets A resist a shear equal to the end reaction R and also a moment equal to Ra, "a" being a distance to be determined later.

In the second case rivets B resist a shear R and a moment M, which, from the principles of continuous beams, is equal to two thirds of the maximum bending moment on a beam of same span simply supported at ends, or equal to two thirds of the moment of resistance of the beam and therefore a constant for all spans when the beam is loaded to its capacity. The rivets A resist a shear R and a moment equal to M minus Ra.

20. But the rigidity of the riveted connection is very much less than that of the beam so that the actual condition of the loaded beam is somewhere between the conditions shown in figures

4 and 5, and just where between, no one can tell. To make the complexity of the problem quite apparent, imagine the supporting beam rigid and all other parts about one hundred times as pliable as they actually are and consider how they would act when loaded. Following are *some* of the things that would happen.

(a) The rivets B, figure 3, will be stretched, sheared and bent, the greatest stretch and bending being at the top.

(b) The material DCHK will be twisted, approximately about CH as an axis.

(c) The upper part of DCVW will be stretched and the lower part compressed.

(d) Rivets A will be sheared vertically due to R and in other directions due to relative rotation of angles and beam.

21. All these effects are in the same direction. They conspire to break down the supposed initial condition — "beam fixed in direction at end." If the support is not rigid, its distortion will conspire with the other effects named. But the worst possible case should be considered and the support should therefore be considered rigid, for if two like beams frame into the support on opposite sides using same rivet holes, the support will remain fixed in direction when the two beams are loaded alike.

22. Several years ago when investigating standard beam connections the writer calculated effects a, b, c for all the standard beam connections then in use. The standard connections have been changed some since that time but not enough to change the general conclusions drawn from those calculations. Of course such calculations would have to be based on approximate assumptions, and that fact was made more plain by the calculations themselves. Without taking space to explain the methods employed or even to tabulate the results, let it suffice to state the general result. A moment equal to that existing at the end of a beam fixed at the end produced an opening of the joint between beam and support as much as or greater than the opening in case of a beam merely supported at the end. Of course as soon as some distortion of the comparatively slender connection has occurred, the moment is reduced and the final opening is less than calculated. Just what moment exists finally at the extreme end of the beam cannot be determined.

23. As previously stated, the moment resisted by rivets A is equal to moment at end minus Ra. If the distortion of the connection reduces the end moment just sufficiently, the resultant moment on rivets A will be zero. In such case the rivets would have to resist only the vertical shear R. Taking account of the shear only is the ordinary method of calculating the connection as has been shown by examining the published tables of minimum safe spans for beams equipped with the standard connections.

24. This common method has not passed entirely unchallenged. Different ones, notably Mr. H. S. Prichard, have pointed

out that these connections are not safe for the minimum spans published.

Mr. Prichard proposes to take account of the moment Ra but makes no reference to any restraining moment at the end of the beam. He treats the beam as simply supported at the end. It has been pointed out that the moment resisted by rivets A cannot be exactly known but is not likely to be zero. If an amount Ra is provided for, a range of double that amount will be covered, from + Ra to — Ra and probably this range will be sufficient, certainly more rational than assuming the moment zero as in the common method.

25. The moment arm "a" of the reaction R is yet undetermined. Mr. Prichard takes it as the distance from end of connection angles to center of gravity of rivet areas A and takes this center of gravity as the center of resistance of the rivets but he explicitly stated that this is an assumption not proved, (Engineering News May 16, 1895.) The assumption seemed quite reasonable but the writer was stimulated to discover a proof for it if possible. A proof was finally developed based on the principle of least work. It is not necessary to record the proof here in full but only to describe it briefly. An expression is written for the work done by the resisting forces of the rivets *against the moment*, assuming that those forces are perpendicular respectively to lines joining the several rivet centers to the center of gravity of all the rivet areas and that they vary in magnitude as the distances of the several rivets from the center since in a safe design the elastic limit is not exceeded. Another similar expression for work done is written for another point as center of resistance, this second point having *any* coordinates x, y with reference to the first point. This last expression is then shown to be larger than the former. The process has to be gone through with for each connection on account of their differences of arrangement.

26. Working then with this value of "a" and any reaction, as 10,000 lbs., find the directions and magnitudes of the stresses in the rivets resisting rotation. To find the magnitude, call that of the rivet nearest to center of gravity x, express the others as multiples of this according to their distances from the center of gravity, multiply each by its distance from the center of gravity and equate the sum of the products to the moment 10,000 × a.

With each stress so found combine graphically a vertical stress equal to 10,000 ÷ number of rivets. On the greatest resultant lay off the safe shearing or bearing stress of one rivet. From the extremity of this draw a line parallel to the stress resisting rotation and cutting off on the vertical the safe reaction R ÷ number of rivets.

Figure 6 will make the process clear.

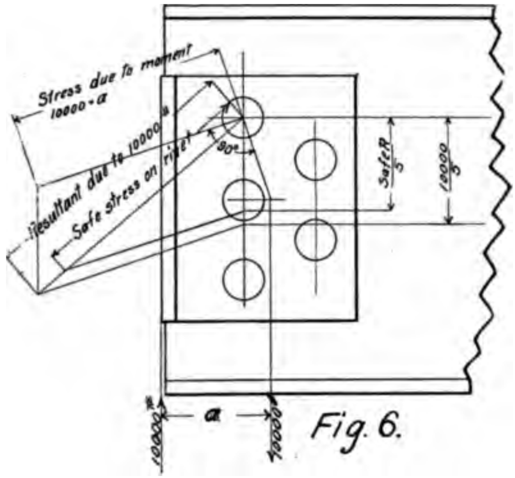


Fig. 6.

Then find the minimum safe span by the formula $l = \frac{C}{2R}$ in which l = minimum safe span in ft., R = end reaction in lbs. for uniform load, C = coefficient of strength given in the pocket books and numerically = 2-3 of the moment of resistance of the beam.

27. Now this method of designing a beam connection is plainly not a rapid one, but if the reasoning is sound it is the correct way. It shows the published minimum safe spans to be too short by from 15 to over 50 per cent. It would be easy to compute once for all a correct standard table of minimum spans and safe reactions for all the standard connections. This ought to do away with the objection on the score of difficulty.

28. It may well be asked why these connections have not frequently failed if they possess the weakness here indicated. The following reasons are offered as a possible explanation.

(a) It is not often necessary to use beams of minimum span loaded to full capacity.

(b) The friction between connection angles and web of beam due to grip of rivets is of unknown but considerable amount. This friction assists the rivets in resisting the moment.

Burr quotes experiments (In "Strength and Elasticity of the Materials of Engineering") made to determine the friction of riveted connections. Slotted holes were used so that friction alone resisted the pull applied. The friction ranged from 8,330 to 22,400 lbs. per sq. in. of rivet section which would mean from 3,680 to 9,860 lbs. for a 3-4 in. rivet.

According to Trautwine friction increases the strength of joints transmitting direct stress by 25 percent.

In this connection it should be remembered that rivets A are the ones driven in the shop.

(c) Experiments by Prof. Lanza on bolted splices (Engineering News Feb. 3, and 10, 1898) seem to indicate that the customary allowances for bearing and shearing are not properly related. The former is much farther within safe limits than the latter. The experiments showed the efficiency of the splices to increase as the intensity of compression in front of the bolts increased and failure occurred in other ways than by crushing. Most of the beam connections are figured on the bearing value of the rivets, hence they may be really stronger than credited.

CONCLUSION.

29. By such a study as this, one is not led to become a hair-splitter in designing, but on the contrary he is familiarized with the fact that many designs or parts of a design are not completely determinate and he must bridge over the indetermination by making such assumptions as appear to him reasonably approximate. Having in mind all the circumstnces and conditions that render the problem indeterminate he will more quickly and intelligently pass judgment on approximate methods of solution. Great advances have been made in the science and art of designing so that the process becomes more and more a rational one rather than an empirical one, but we shall probably never get entirely away from a factor of safety, or, as it is often called with equal appropriateness, a factor of ignorance. [Applause.]

Paving a Country Road.

SAM HUSTON, C. E., STEUBENVILLE, OHIO.

The perfect surface for a highway has never yet been secured. Different conditions, available materials and circumstances that must be considered in planning for, and carrying out the improvement of highways, like every other problem confronting the civil engineer, require original work to secure what is best for each particular case. Where excessive traffic and available funds combine with surroundings wherein noise is not essentially dominant question, the granite paving block must for the present assert its exclusive right. Available funds with the moderate traffic of a residence street, where the necessity of elimination of noise and the securing of a smooth even surface become the essential questions, require some one of the forms of asphalt paving as the necessary solution of the problem.

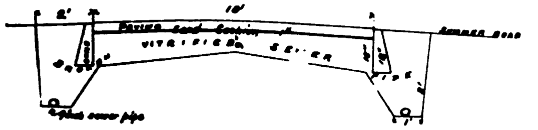
Limited means available for the original cost of construction, and accessible trap rock solves one phase of road construction fairly well, whilst lack of the last named material, together with available limestone forces the adoption of this comparatively inferior material as the only solution in many cases.

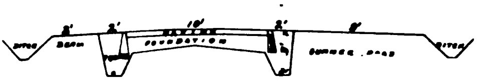
Successful engineering consists in the economical use under local conditions of the most available material, and its adaptation in the most practical way to the accomplishment of the greatest economical, enduring and serviceable results.

The description below of what is in some measure an experiment, is evidently the best solution possible of existing conditions, which whilst necessarily not of wide extent, yet, will be found applicable to many other localities.

The first circumstance or condition entering into the problem was the location of the road, it was proposed to improve, along the bank of the Ohio river at such an elevation, or rather want of elevation, as to bring about the covering of the road, on an average of about once a year, with high water, carrying to its fullest capacity the fine sediment resulting from the disentegration of coal measure shales, and leaving thereon, after subsidence a tenacious and retentive mud, absolutely destructive to the surface of a macadam road and thus requiring excessive expenditure for maintenance. The thorough occasional soaking of the road bed attendant upon these high water stages, added another element to the problem of construction, with permanency in view. In this I recognize the only element of uncertainty as to the success of the experiment.

The conditions favorable to the experiment were the location of the road with reference to the materials used in construction, that is past works producing what are, without any question the best paving brick manufactured, the celebrated Ohio river paving brick, manufactured under conditions as to economy of production rarely equaled. For material for foundation the same element of accessibility of waste material from sewer pipe works, made it possible to adopt that nearly indestructible waste for the construction of a foundation which we hope will neutralize the uncommon condition due to soakage referred to above.





The drawings herewith are illustrative of the references in the description below, which are but explanatory of the selections quoted from the specifications under which the road was con-

structed, the selections given are only those referring to requirements peculiar to the form of improvement under consideration. A complete copy of the specifications were printed in the last annual report of the society.

> "Four inch sewer pipe drains, length of joints two feet, shall be laid true to grade in the trenches at sides of paving as indicated on cross section sheet, and will be practically continuous on each side of the pavement. All sewer pipe shall be of shouldered, hard burned, glazed fire clay pipe of good quality. Fire cracks or slight deformations that do not affect strength or capacity will be allowable, but pipe otherwise defective must not be delivered along the road."

These four inch sewer pipe were placed in trenches under the curbing, and three feet below the finished grade of the road, not because the ground was more than ordinarily in need of drainage, it being mostly a sandy loam, but in order to effectively and promptly carry off the water under the paving upon the recession of the frequent floods referred to above.

The grade, spoken of above, throughout nearly the entire length of the road improved was from three to twelve inches to each one hundred feet. The three inch grade I considered undesirable, but funds were not available to secure a heavier grade, although we used the debouchure of several minor streams, about one thousand feet apart, to secure without much extra expense the above minimum grades, and at the same time not bring the lowest points of the pavement below a certain uniform minimum, about one foot above the level of what are considered dangerous floods. For a distance of about sixteen hundred feet the pavement was laid over material six feet or more in depth consisting of the waste from fire clay brick kilns and sewer pipe works, this material gave good drainage, and it was deemed unnecessary to use the four inch tile over such fills. Otherwise the double line of tile was continuous for the entire length of road.

> "Foundation material shall consist of broken vitrified sewer pipe, which shall be broken to pass through a two and a half inch ring, with sufficient finer material to fill voids after rolling, and prevent sand cushion from passing downward. Such material shall be placed in the trenches, over the four inch pipe and around the same up to within eighteen inches of the surface of the sides of the completed pavement, and together with the sub-grade, shall be thoroughly rammed, or rolled with a roller weighing or weighted to eight tons. Said work being done when the sub-grade is in a moist condition, and care shall be used that the sewer pipe are not injured, crushed or displaced."

The material used was the waste of the works consisting of rejected and unmerchantable sewer pipe, broken by hand with

light sledges, mostly in the trenches and on the sub-grade. For finer material furnace cinder was used by consent of the Pike Commissioners, and if there is any weakness about the manner of construction, or carrying out of the specifications, it arises from the use of too large an amount of cinder, and a want of proper incorporation of the same with the broken sewer pipe. The sub-grade was rolled and any unforseen unevenness growing out of the nature of the material of the sub-grade, was made up with the foundation material.

> "Curbing of quality and manufacture the same as Ohio River paving brick, eighteen inches high, three inches wide on top, and seven inches wide at the base, and not less than two feet long, and of the form indicated on cross section sheet, shall be placed and solidly bedded on the foundation as designated above, so as to stand true and even to grade and line."

This form and material of curb, so far as I know, is entirely new, was designed by the writer, and so far as the construction of the road is concerned has proved its efficiency. In order to secure thorough burning it was constructed hollow, with walls one and three-quarter inches thick, is solid and substantial, having stood every test applied to it. Transverse fire cracks, where not too extensive, appeared of no detriment, but longitudinal cracks, and inferior burning were the only defects calling for rejection. It was found that with proper care in handling during the process of manufacture, these defects were of infrequent occurrence. Where the whole curb is buried as in the manner used in the road under consideration, they were found to be all that could be desired, and demonstrated their serviceability. Curbing,, I believe, could be manufactured on the same plan adapted to gutter work, provided they were bridged in the hollow against which came the pressure of the brick forming the gutter. The reasons for building the curb hollow were to secure uniform burning through the entire cross section of the curb, to save material not necessary to strength, and reduce the weight an important item in the cost of manufacture. The weight of the curb was sixty-eight pounds per lineal foot.

> "In the trenches partially filled as above and upon the sub-grade shall be placed layers of not more than six inches in depth of above specified foundation material, each layer of which shall be rolled or rammed to the satisfaction of the Engineer. The surface of such material when complete and rolled, shall fill the trenches outside of curbing to the level indicated on the cross ' ' ' 'et as surface of completed

road, and between the curbing to within four and one-half inches of the same, with smooth and even surface, with same curvature as completed pavement. Between the curbing and upon the foundation thus prepared and thoroughly compacted, a layer of clean, dry sand shall be placed, and shaped to the form shown on cross section sheet by a templet scraper, with a depth of one-half inch. The above with the sand cushion shall be classed as foundation, and be bid and paid for by the cubic yard, measured when the road is complete."

In the construction of the road one inch of sand was used instead of one-half inch, and the surface of the brick, when the rolling of the same was complete, stood one-half inch above the curbing to allow that much settlement under travel. The crown of the road was determined by the form of the templet scraper referred to in the specifications. The scraper was made as follows: that is ten feet long with the following measurements from a chord uniting the ends and at the following distances from the center; center two inches, one foot from center one and seven-eighths inches, two feet from center one and one-half inches, three feet one inch, four feet one-half inch; thus forming a curve for four feet at the center, tangent to a slope of one-half an inch to the foot for the remaining three feet at each side of the paved portion of the roadway. This latter slope was carried across the summer road and wing at each side of the paving. This brought the farther edge of the summer road eight inches below the center of paving as follows: Crown in paving two inches, side of paving above curb one-half inch, fall of one-half inch per foot of trench (curb and broken pipe) two feet, and summer road nine feet, in all eleven feet five and one-half inches.

"Upon the sand cushion the brick paving shall be laid. The brick shall be of standard size of the best quality, sound, tough, Ohio river fire clay paving brick, hard burned, of good shape, free from flaws, cracks or breaks. No bats shall be used except at curbs, where half bricks shall be used to break joints. The Engineer may subject samples, selected by himself, to any reasonable tests as to durability and fitness. Bricks shall be subject to any inspection designated by the Engineer, both before and after laying, and all rejected brick shall be immediately removed from the work, and not returned to it, and the deficiency made good by the Contractor."

"The brick shall be laid on the sand cushion, on edge, at right angles to center line of paving, and be kept in even, straight lines; with all joints broken at least three inches, and in perfectly upright position, the brick to fit close on ends and sides. In making closure at curbs, care shall be taken in shaping and trimming not to check or fracture the

bricks, which shall be broken or cut at right angles to their tops and sides, and the work shall be done by experienced men."

"The brick shall then be covered with fine dry sand to be well broomed in, sufficient only to fill the interstaces of joints. When laid as above, the brick shall be thoroughly rolled with a roller of five tons weight, and any portions of the pavement, that in the judgment of the Engineer may require the same, shall be rammed to his satisfaction, either before or after rolling, a plank being used under rammers. After rolling, the surface of the paving shall be true and even to grade and cross section, must show no continuous lines, or unequal settlement, and the Contractor shall remedy any such deficiencies. When complete as above the surface of paving shall be evenly covered with one-half inch of clean, dry sand."

In reference to the last quotation it is only necessary to add that the brick used, the "Ohio River fire clay paving brick," have proved themselves, according to my observation extending over more than twenty years, and in comparison with many other kinds of brick used in different cities, and under various conditions, the most reliable and enduring pavers manufactured. I have seen them in quite a number of cities used on adjoining streets to many other kinds of pavers, and they have demonstrated their superiority especially in the line of durability.

The sand used on the first paving laid was rather loamy, and would undoubtedly have proved detrimental, had not several weeks of extremely dry weather succeeded to its use. This dry season however counteracted any tendency injurious to the road, and clean, sharp sand was used subsequently.

The following is a copy of the final estimate on the work:

Excavation, 10,334 cubic yards per 12 cents	$1,240 08
Overhaul, 47,490 cubic yards per 1 cent	474 90
Grubbing trees, 18 per $1	18 00
Sewerpipe, 4-inch, 8,012 feet per 6 cents	480 72
Curbing, 10,784 feet per 20 cents	2,156 80
Foundation, 3,413 cubic yards per 22 cents	750 86
Paving, 6,243 square yards per 52 cents	3,246 36
Total	$8,367 72

The total length of paving exclusive of bridges was five thousand four hundred and seventy-nine feet.

The low price for excavation was obtainable because the contractor was able, before the work was let, to arrange with a manufacturing plant located within three hundred yards, to use their waste for the construction of the heaviest fill on the contract, which material was delivered in place wi[illegible] [illegible]e to

the contractor. The price for overhaul one cent, was for each one hundred feet or fraction thereof each yard was moved in excess of one hundred feet.

THE CHAIR: There are not a great many places in Ohio, I suppose, where a country road could be paved at any such expense. It was exceptionally located and they took advantage of that fact. They have a well built country road at much less cost than it could be built in the cities. The same brick are used in the cities as were used there for paving a country road. Are there any remarks on this paper?

MR. KEMMLER: There is one point there which might be open to dispute, and that is the sand cushion. I notice he speaks first of using a loamy sand, but thought it might be detrimental and afterwards used clean, sharp sand. Here in Columbus, we do not like a clean, sharp sand, but want one with eight or ten percent of clay in it to make it easy to work and pack. The sharp sand will not pack and has a tendency to run. A loamy sand will pack and become hard. A briquet made of clay, or even of loam, will sometimes pull almost as much as a cement briquet. So I doubt the efficiency of sharp sand for that purpose.

THE CHAIR: It will be interesting to learn afterwards what will be the difference in wear, after a couple of years.

The Improved Roads of Ashland County.

F. L. NIEDERHEISER, COUNTY SURVEYOR.

The engineering problems presented by a road improvement necessarily vary with the Topography of the country, the character of the ground over which roads are to be built, and the proximity to proper roadmaking material, as well as the laws and the officers under which they are made.

The part of Ashland county in which improved roads have been constructed is rolling and in some parts hilly, yet not presenting, in the condition of the roads before improving, greater gradients than 10 percent., and these not frequent nor long. To engineers from the more hilly portions of the State it might seem that those roads need but little grading, yet we have not constructed a mile of pike in which we have had less than 2000 cubic yards of grading, and in some cases it has reached as high as 5000 cubic yards per mile. Our idea being that the load on an improved road is governed by its steepest grade, we reduced the gradient as much as possible, the steepest slope on any of the improved portions being 5.9 percent. In some cases it was neces-

sary to do grading in order to remedy the dead level of the natural road, as drainage is essential to proper road-making.

One difficulty we encountered was the objection of residents along the roads to having a deep cut along their properties, and that of many persons to high fills and deep ditches along the roads. Some of this objection was overcome by placing tile in the ditches in front of residences and at crossings to fields, etc., but we find ourselves subject to much unreasonable criticism where we build up a road across a valley 3 or 4 feet above the adjoining fields, the principal argument being the liability to upset if one should drive off the road. However, as the people drive over these roads and become accustomed to them the objections grow less, and every day of thawing weather and muddy roads advertises our pikes more than any amount of argument, however forcible and logical.

As to the character of the ground over which our roads are built, we are blessed with all kinds from muck to short stretches of fairly good gravel, clay predominating. In many places our roads are spouty, and in bad weather, likely to have sink holes of considerable depth. I had a little experience with one of these places myself one night, being compelled to stay by it from 8 to 11 o'clock, and only getting out by the kind assistance of a farmer living near by. I am happy to state that I had the pleasure of building a good fill and pike over that place, so that it can now be traveled in safety at any season of the year.

The most difficult problem with us, is procuring proper road-making material as the gravel in the creeks or banks nearby, is composed chiefly of shale rock which disintegrates very quickly under the action of wheels and frost. We were therefore compelled to use limestone which is not procurable nearer than Marion or Bloomville, and costs more for freight than for the material itself. This item of expense, therefore, induced our trustees to build a single track of pike 10 feet wide with a dirt road alongside, as well as to use a foundation of gravel 6 inches thick under 10 inches of limestone. As to this method of construction, while it may not be the best, it may be said that the dirt road saves the pike in good weather, and certainly affords the best kind of a road when in good condition, and being protected from the traffic in bad weather, it is soon in good condition when the weather permits. The principal objection to the pike is its width, which ought to be enough to allow of changing the track so as to avoid cutting deep ruts as is the case on so narrow a roadway as 10 feet. I think 12 feet would be much better in this respect. Then as to the foundation of gravel, it can be said that it keeps the stone from sinking into the mud and furnishes additional drainage, which are certainly desirable conditions.

Our work is being done under the law of 1896, and our trustees have been greatly interested in the work and have spent

much time in visiting other parts of the State where stone roads have been constructed, and ascertaining the most approved methods and practice in road-building.

One feature of the work as we have done it which seems to me to be very important is the ditches. We specify that the ditches shall be 2 feet wide on the bottom, have a slope of not less than 1½ to 1 on the side toward the road, and 1 to 1 on the other, and shall be 1 foot below the edge of the road or 18 inches below the highest part of the dirt road, and I firmly believe that this construction of ditches has done more for our roads than any one other thing in the entire construction; for the grading amounts to but little if the water is not kept off, and the road material would soon be lost if put upon undrained roadway.

All our work is rolled with an 8 ton horse-roller. No doubt a steam roller would be better, but one objection to specifying steam rolling is that comparatively few contractors own steam rollers and that item in the specifications would often keep men who could and would do good work from bidding, as the cost of a roller would take a large share of the profits, and the machine might soon become an elephant on the hands of the contractor.

For top-dressing or binder we use enough limestone screenings to fill the interstices, and roll when wet. We prefer the screenings as they come from the crusher without having the fine particles removed as we find that this cements much more rapidly and makes better work.

Our work last year cost about $3000 per mile, the price of the various items being as follows: Grading, 18 to 20 cents per cubic yard. Gravel, 50 to 85 cents per cubic yard. Limestone, $1.12 per cubic yard. Hauling and placing limestone on road, 35 to 55 cents per cubic yard. Rolling, 2½ cents per square yard.

Our roads so far, are in very good condition and are growing in favor every day. Only one township (Montgomery) has voted to improve its roads under the statute above referred to, but at least two adjoining townships may vote on the question soon, which we think will result directly from the improvement already made in Montgomery township.

Our farmers are awakening to the fact that their lands become more valuable as their roads are improved, and good roads along with telephones, rural delivery, etc., certainly add materially to the happiness and comfort of those living in the country. [Applause.]

PROFESSOR GILPATRICK: I would like to ask if, in cutting hills, you have any trouble with owners of property abutting?

MR. NIEDERHEISER: We have not had any great difficulty.

PROFESSOR GILPATRICK: Do they ask for damages when you cut the hill in front of their premises?

MR. NIEDERHEISER: Yes, sir; they get out and kick. We cut three or four feet, and in some places five or six feet. The most trouble we had was in filling up in front of property.

PROFESSOR GILPATRICK: Did they ever enjoin you?

MR. NIEDERHEISER: We never let it get that far.

PROFESSOR BROWN: You say you use limestone ten inches, gravel six inches: did you ever think of turning that around, on account of the great cost of stone?

MR. NIEDERHEISER: I had thought of that, in view of the reports from New Jersey and other places where a thin layer of stone had been used, and had thought it might be a good idea. But the fact is that with a ten-foot-wide roadway, our roads rut pretty deep in the winter and we have to rake them in the spring until they get compacted. In the next place, we do not know who is going to keep these roads up and if we get ten inches of limestone on we know it will keep much longer.

PROFESSOR BROWN: My understanding of the New Jersey road is that they used four to six inches of stone right on the road, without any foundation.

THE CHAIR: This law under which this improvement was made — I remember of reading that four or five years ago, where the township takes it up — and what proportion is paid directly by the men owning the foot frontage?

MR. NIEDERHEISER: This law provides for a petition signed by a hundred freeholders, which goes to the trustees who allow the whole township to vote on it. If it carries the entire expense is levied upon the general duplicate of the township, including the villages.

THE CHAIR: Do they vote on each road separately?

MR. NIEDERHEISER: No; they vote on piking the roads of the township. The law limits them to fifty thousand dollars, and when they have spent that amount they must wait before improving other roads. They can pike any regular recorded county road. I believe the law provides that the main travelled roads shall be piked first, and no road less than forty feet wide shall be piked. But when we want to improve a road less than forty feet wide, we make them open it up to that width.

THE CHAIR: According to the report made by Mr. Evers, read this morning, work is being done under this later law, by which on petition the landowners call for the improvement; then the commissioners, or a commission appointed by the commissioners, if there is any ob,jection to them making the distribution, distribute the cost of the improvement, and so much is paid by the county and so much by the landowners. There are so many road improvement laws that in some counties it is getting to be a very hard matter to carry out the best ones. For instance, in

our county at one time they bonded the county to buy the toll roads. Then they used the two mile assessment law for awhile. Then, in 1888, I think it was, they had a special law passed allowing the commissioners to levy in the neighborhood of twenty thousand dollars a year — before that came the special laws designating the piking, such and such pike to be improved and authorizing the Commissioners to do so. Then came this other special law making a levy on the grand duplicate of the county, the Commissioner distributing it as he saw best, and this is continued to this time.

MR. NIEDERHEISER: I do not know whether this law of 1896 is the best or not, but it has this advantage — we do not have to ask one farmer to go down in his pocket over and above his neighbor. He simply pays in the general duplicate. Then our towns have to pay just the same, as they also are benefitted by increased traffic. We also get some work inside the corporate limits, as the law provides we may. Our town of Ashland pays at least two thirds of the tax for these roads, but there is less objection made to it in the town than in the country.

Extempore Address on the Work of the United States Geological Survey.

BY PROF. BROWN.

I have a map here showing the work which has been done by the United States Geological Survey in cooperation with the State of Ohio, in making a topographical survey of the state. Both last year, and I think three years ago the Society took some active interest in the matter and I thought it would be interested in knowing what has been done. I might say that at the meeting of the legislature two years ago, a bill was passed appropriating twenty five thousand dollars to be used in co-operation with the United States Geological Survey in making a topographical map of Ohio, the same not to become available until last spring and to furnish money for one season's field work. It was expected the work would take about eight years, doing the amount of work done last summer each year. The agreement is that the United States Geological Survey will furnish as much money for field work as the State. The State furnished twenty five thousand dollars last year and the United States Geological Survey furnished a like amount. Then, the United States Survey maps the work, makes the engravings for the maps and publishes the maps without cost to the state. These maps are then for sale to anyone who wants to purchase them at the rate of five

cents per sheet; or if a number are wanted, a hundred or more, a rate of two cents a sheet is made, each sheet covering seventeen or eighteen miles made to a scale of one mile to an inch, very closely.

Before the work had been begun by the state in connection with the United States Geological Survey, a little work had been done in the state by the Survey itself. On this map (exhibiting topographical map of Ohio showing work thus far done) the little rectangular territory tinted pink, here (indicating), at Ironton, Cincinnati, Columbus and Toledo, show the areas which had been mapped and maps on sale previous to the taking up of the work by the state. It was really done to furnish samples to be used in getting the bill through the legislature.

Also, other work has been done by the various other bureaus of the Government, which can be used in this survey. For instance, along this blue line (indicating), and this from Detroit to Cincinnati, the United States Coast and Geodetric Survey had run lines of precise levels, leaving bench marks which can be used in this work. The United States Army ran a line from Pittsburg to Cincinnati, leaving bench marks which can be used. The Coast and Geodetric Survey had also run a chain of triangles through the lower part of the state, determining geographic positions, and the United States Lake Survey has a chain of triangles across the upper part. So along the lake shore and through the southern part of the state considerable triangulation has been done which can be used in this work.

During the past season work has been done in co-operation with the state as follows. This area (referring to map) tinted green has been completed as to surveys, the manuscript maps are now being made in Washington and the finished maps will be published and for sale sometime during the coming summer. These two rectangles (indicating), one up near Cleveland and one we call the Scio sheet, having green stripes over them, are not quite finished, but will be completed early in the spring.

You will notice that there is a considerable area in the uorthern part which is laid off in checkerboard fashion, also some in the eastern and some in the southern parts of the state, marked off in heavy red lines. In the areas so marked, which form a considerable part of the state, part of the field work has been done. That is what we call work for horizontal control. Points have been located by triangulation, or otherwise, to permit us to go on and do the field work for detailed work, so that parties can be put in here and have it worked up at once.

Returning to the work, the custom of the Survey has been to make the contour interval on all maps with an inch-to-the-mile scale, twenty feet. On the Toledo, Maumee and Oak Harbor sheet, where there is a good flat country, in some places they are five miles apart. There is a good portion of the north-

west where it will be pretty much the same way. But it seems to us that this will not show the relief of the country, the shape of the country very well. So the matter was laid before the Director of the Survey and we have platted all this part with a ten-foot interval, and it will be so mapped. The part to the south and east of the ruler (indicating by holding ruler diagonally across map), roughly estimating, will probably be mapped with a twenty foot interval; while all to the northwest will be mapped off at a ten foot interval. That line has not been determined on definitely yet, but will be as the work goes on.

The maps made in other parts of the United States showed the location of all houses, school houses, manufacturing establishments, churches, etc.; and we thought it might be well if public buildings could be designated differently from the dwelling houses. That matter, also, was laid before the Director and it was concluded in Ohio to indicate by appropriate symbols churches, school houses, town houses, etc.

In each district permanent bench marks are located, on court houses, large bridge abutments, and places of that kind, putting two or three in a township and stamping on each height above sea level. That is marked to the nearest foot, but I think a change will be made whereby the marking will be done to the nearest tenth foot. Sometimes in running levels it is convenient to have the nearest tenth foot.

This illusrates the work which has been done. This winter a bill will be brought before the legislature asking for a continuance of the appropriation and it is hoped and expected that the legislature will provide twenty five thousand dollars for next summer and for the following summer for a continuation of the work. At this rate it will take about eight years to complete the mapping of the state. I might be asked why more money is not appropriated and the work completed sooner. The United States Geological Survey does not want the work done quicker. They say that to properly look after the work and to keep on hand a sufficient number of qualified men, they do not want to undertake to complete the work quicker than indicated by the expenditure of fifty thousand dollars each summer for field work.

It might be well for each engineer to speak a good word to his representative in the legislature in behalf of this work.

PROFESSOR GILPATRICK: Was the entire fifty thousand dollars expended last summer?

PROFESSOR BROWN: Yes, sir; within eight hundred dollars or so.

PROFESSOR GILPATRICK: I notice there distance given in latitude and longitude: do those marks record in miles also?

PROFESSOR BROWN: There is a scale of miles given on the map. The map is made to a scale of 1 to 6250: that is, one foot on the map is 6250 feet on the ground.

PROFESSOR GILPATRICK: I was hoping there might be something done in the survey to aid this question of monuments in land surveying.

PROFESSOR BROWN: No; the Geological Survey refused absolutely to do that. Down in this area already mapped, they did not show any section lines at all. These two at Cincinnati, one at Columbus and these three at Toledo did show section lines. There is a difference of opinion among the officers of the Survey as to whether they shall show section lines. I think we will win out and have the section lines shown.

PROFESSOR GILPATRICK: What is the objection?

PROFESSOR BROWN: There is quite a little interesting story back of that. Ohio lays sort of betwixt and between things, and we have two men in charge in Ohio. The entire United States is divided into four districts for the purpose of administration and Mr. Wilson has charge of the Atlantic section, embracing the Atlantic coast and Allegheny system. The Allegheny Mountain system runs to a feather-edge in Ohio. Western Ohio belongs to the Basin District of the Mississippi, under Mr. Renshaw. All of Mr. Wilson's work has been done in the eastern part of the United States where they do not have section lines and he never came against section lines until he came to Ohio. He had paid no attention to land lines and was opposed to doing it here. But Mr. Renshaw had worked out in Kansas, Missouri, and those western states where attention had been paid to these lines and he put them in. So there is a difference of opinion in the Survey itself. Now, I think Mr. Wilson will be converted and that the Section lines will be shown.

There is another matter under discussion: that is, the giving of section numbers. Mr. Renshaw had worked in the far west where the numbers ran nice and smooth and he was in favor of giving the numbers, but he did not know the conditions here.

PROFESSOR GILPATRICK: Will only that part of the state divided into sections have section lines shown?

PROFESSOR BROWN: Yes, sir.

PROFESSOR GILPATRICK: May I ask if it was not the purpose, when this project was set forth, to set monuments at the corners of these rectangles and thus help out the land surveying?

PROFESSOR BROWN: I think that was talked of, but I do not think Mr. Wilson ever admitted the thing. I think he rather dodged those points. It is the expectation of the Survey to make a survey only so good as is necessary to make a map one mile to the inch. They do not preserve the field notes at all. After the map is made the field notes are thrown away. So if they get things located within 25 feet, it is good enough. For instance,

the wagon roads are all run in by counting the revolutions of a buggy wheel. For the purpose of making that particular map to that particular scale their work is plenty good enough. It would not do to survey land by that. It would need a map probably to a scale of six inches to the mile.

PROFESSOR GILPATRICK: I confess that I am very much disappointed in the outcome. I recall the circular letter sent out by Professor Wright and his presentation of the matter to the Society led me to think it was going to be a great help to land surveying.

PROFESSOR BROWN: I think it will be helpful to land surveying in many ways, but in the detail of the work I don't think it will be so much.

THE CHAIR: What would amount to more to land surveys in the direction of getting monuments set in two or three years, would be to have all descriptions marked up as "correct" or "incorrect." If a man bought land which was marked "incorrect" as to description, he would be pretty sure to have it surveyed and monumented. Regarding the old military lines, the surveys were often exceedingly inaccurate, and much of it has not been surveyed since the original survey was made. I suppose in some tracts there is still several times the amount called for, though probably none as bad as the case in Adams county which called for 75 acres and contained several thousand.

Electric Railways Between Distant Terminals.

BY ROBERT E. KLINE, DAYTON.

Since the adoption of electricity as a motive power for propelling cars, there has been a constant development in ideas as to the possible length of lines to be built for successful operation.

In the first place the electric car became a subsitute for the horse-car which was for some time previously the common carrier for passengers merely upon streets of our larger cities.

Within the last decade the advent of the Inter-Urban electric railway has followed in a remarkable development, in the state of Ohio, probably more than in any other in the middle West.

The construction, equipment and operation of single lines connecting adjacent cities and towns within the same or contiguous counties has become quite prevalent.

But recently, the idea of building electric railway lines connecting distant towns for establishing through service, has attracted some attention.

Upon this point, we are led to a discussion of some pertinent considerations for practical results.

By reason of the fact that commercial centers in various counties throughout this part of the country dot the map in approximately uniform spacing, these same points very frequently being county seats, the line of travel naturally has led to their connection in providing therefor.

Following this idea electric railway lines have their location in practically direct line connecting such cities, thereby serving the immediate towns and territory as well.

Frequently by consolidations and very often by extensions of lines already constructed, a chain of such commercial centers are served by one long line.

This method of development has been responsible for our first through lines connecting distant terminals.

Under this method of development, the various equipments forming links in the chain of lines constituting the entire system, are such, being designed for comparatively short distances, as to be somewhat unsuited for speedy through service and the cost of operation is by no means near the minimum now attainable in the use of more modern and better adapted equipment.

Without a knowledge of the ultimate use of any of these lines in such manner, the provisions for necessary speed and for heavy haulage, to an extent a necessary adjunct to successful results in the operation of through lines, were not looked after with due attention.

Heavy grades and sharp curves crop out at numerous places, because, for the original purposes, these were to an extent permissable.

In the equipment for power, the direct current system, in most cases adopted as being adequate for the required feeding distances can not be made serviceable to points very far beyond the points of original terminals, so that each successive line between the extreme terminals carries its separate operating expense in power production.

Consolidation usually resulting in the interest of the attainment of highest efficiency, points out where reconstruction and re-equipment are very often essential.

Just how far such consolidations can be made so as to work the best, practical advantage is a problem worthy of attention and study.

Is there a practical limit of distance to be provided for through travel upon the electric railway?

Eliminate the factors that impede such operation and the preponderance of advantage of the electric line for passenger travel becomes as positive for the greater distance, as is true as has already been demonstrated upon lines of shorter length, of which kind we have many practical evidences.

When distance between remote terminals has been rendered less apparent by increase in speed by adoption of latest methods

of construction and power equipment, adaptable thereto, cities and towns of greater distance apart are brought together in but little greater time than now required between closer towns, where successful operation is already a certainty.

Service of electric lines in most instances has greatly increased intermediate travel between local towns, to the utter amazement of all hitherto skeptical steam railway owners and to an extent far beyond the expectations of the most sanguine electric railway promoter.

Some reasons for this are apparent because the service is usually from 5 to 10 times as frequent as that ordinarily afforded by the best steam railways, and the advantage in convenience of access to cars in and between towns, as a rule is proportionately as great.

It is worthy of note that this is accomplished with the use of materially no greater time or energy, than for steam service having less patronage.

This more frequent and better service, securing greater business, employs, as nearly as attainable, the capacity of power provided and the highest possible efficiency is thereby realized. Very often this is not true of the steam railway.

The tendency to increase capacity in size of electric passenger cars should not be carried to the extreme. The electric railway idea of lighter cars in more frequent service should not be radically departed from. This is especially true on lines whose distances between terminals are not so great.

Through travel demands somewhat more elaborate provision for ease and comfort of patrons, and this necessarily means more convenient and thereby larger cars. Upon this point there should be an exercise of careful judgment in the avoidance of extremes.

As to a limit of distance between terminals, generally speaking, there can be none.

To the business done upon a single line, ordinarily there is shown a material increase in the net returns when through service is established, by joining consecutive lines. This is brought about not so much by through patronage, but greatly on account of what may be termed a relay travel, thus making it possible and at same time adding to the usual local travel. When the conditions for more successful operation in through service are provided, through travel is not only increased, but local business is bettered at the same time.

In this part of the country the building of new steam railways has been practically at a standstill, in the past few years the advance being principally in improvements upon permanent way and rolling-stock.

This is due to a great extent to the fact that practical routes for such properties locally are nearly all utilized.

From the fact that an electric line can build and operate over much rougher territory, with much less cost of construction, maintenance and operation, business communication can by this means be established between terminals over routes that are inviting yet heretofore considered impractical from the standpoint of practical construction for the steam railway.

In this respect the through, as well as the local electric line has perhaps its largest field before it, as yet practically undeveloped.

In construction in this field, attention to provision for utmost economy in the equipments for efficiency in all kinds of service will have attention based upon past experience in alleviation of grade and curve conditions and power development and distribution.

The promoter who departs from the steam railway into virgin territory is yet apt to meet discouragement from railway financiers, who at this time, have taken up propositions most readily very often practically parallel throughout to steam lines.

In this new field freight as well as passenger business will be to an extent a material factor.

Many possible routes are open to-day for a proper expenditure in construction and equipment in the field of electric railways which in many cases are of some great length.

A decided feature of advantage is that the electric line can tap the heart of towns upon principal streets and the country along main thoroughfares, which is impossible to the steam railway.

Concentration in production of power, heating and lighting from larger plants will follow in the future effort to attain the greatest ecenomy.

The electric railway can profit by this method where the steam railway can not under the present plan of locomotion.

The owners of certain steam roads have come to recognize the electric railway as a serious competitor in local business.

In most cases the increase in through business done between distant terminals is ample to justify a passenger service passing points where such competition exists.

It has been demonstrated that steam railway through business has been increased materially by these new lines as they encourage much new through travel, because they come more directly in touch with the people as a result of their location.

It is to this largely that the percentage of through travel today has its greatest increase in localities so served.

There has been a disposition on the part of some railways to fight the electric line but the more liberal have adopted a policy of encouragement and are making investments to the end of control in some cases.

This, it is shown, would have been good policy in many cases heretofore when at the outset such control was most easily obtainable as against an attitude of opposition and fight.

The electric railroad as such will never ultimately supersede the steam railroad in the handling of all through travel, there will no doubt eventually be a unification of interests to the common advantage of both, the inevitable ultimate result.

The better grades and alignment and more elaborate equipment in construction and operation of steam railroads, will always assure them a performance in a highly remunerative use in through travel, but they must be astir as is apparent in order to meet successfully the new requirements shown them as necessary in order that they may cope with the electric railway in its every stage of development.

There is but little reason to doubt that ultimate order will follow the occasional present indication of unprofitable competition in certain cases, to the satisfaction of investors in both these channels.

The traveling public and the business world are sure to be benificiaries due to the better, less expensive, and more general and far reaching systems of service perfected in this manner.

In conclusion, by way of summary, it has been the purpose to demonstrate that the limit of distance for practical results in the province of the electric railway as a mode of through transportation, is a variable one.

In addition to the conditions which justify the building of steam railroads, which follow in case of the electric line in most instances as well, the latter has a practical use in a new and larger field as shown.

The electric line is in position to join in the movement of economizing physical forces by the establishing of central power, heating and lighting plants.

While the electric line in many cases becomes an active competitor of the steam railway, thereby inducing better service their interests will eventually become common, the one subserving the other.

THE CHAIR: Are there any questions to ask or any opinions to express on this subject? I would like to ask Mr. Kline how the steam roads are treating them about Dayton as to crossings, whether they fight or try to compromise on reasonable terms to both parties?

MR. KLINE: The usual result is a compromise, but they begin by fighting.

A MEMBER: They fight as long as they can?

MR. KLINE: Fight as long as they can, yes.

THE CHAIR: Do they usually offer to pay their share to make an overhead or under crossing rather than have an interlocker? By the state law they have to pay their half of the maintenance.

MR. KLINE: As a rule, they have not been willing to pay much, though at this time some advance has been made to the end of joining in overhead crossings.

THE CHAIR: One road here has agreed to do that and the crossing is in process of construction. They are paying one half of the expense, and it is a big expense, of putting in an underground crossing. The Norfolk & Western fought one road in the courts, refusing to pay one half of an overhead steel viaduct. They went into court and the electric road finally agreed to pay one half the expense. When a steam road in the beginning offers to pay one half the expense of an overhead or underground crossing, it is not much use for an electric road to fight for a grade crossing. The situation in Columbus is that the roads controlled by the Pennsylvania Company are ready to compromise, but the others are not.

PROFESSOR GILPATRICK: I would like to inquire in regard to paralleling quite prominent railroads, such as the C. H. & D. road to Cincinnati. It strikes me as perhaps an undesirable project to run an electric line parallel to such a road as this. I would like to know what Mr. Kline's opinion is upon this point. I can see the advantage of running between county seats and prominent towns, furnishing means of communication between intermediate towns, but to run a through line between such points as Toledo and Dayton, for instance, paralleling a steam road, strikes me as perhaps undesirable.

MR. KLINE: My judgment in that regard, Mr. President, is that the ultimate result will show that the line constructed will pay well and that the steam railway paralleled will have a substantial increase in through business over its present business. This will be due, in my judgment, to the fact that the electric railway diverges from the steam line for short distances through towns (not far), and in the intermediate territory it picks up and stimulates travel which otherwise would be almost inaccessible. Take, for instance, a resident along a thoroughfare, ten miles from town where the railway station is located. Then consider that between the towns there are hundreds of such people who travel but once in a year because of the poor facilities to get to stations — there is no stimulus to travel. But when they have this means at the door, they will take advantage of it. As a result, the electric line gets this business; and as has been shown, the steam road profits by increased amount of through business in the same way. If a man travels once a year in through travel when he has nothing but the steam road, there are liable to be a hundred people travel in a year from the same

points when the convenience of the electric road is at their doors, and it is bound to stimulate through travel throughout the country. The steam railroad gets the advantage of the through travel from points along this line, and also from other lines terminating at other points, and also from the interchange of travel between steam roads, all of which increase of business will have been brought about by the introduction of the electric road. I read an account of such a case in some part of Michigan, where an electric road paralleled a steam line, and the increase of travel on the electric line over that originally carried on the steam line was as five to one; and the steam line did a business substantially larger than before. These lines were about parallel.

The first tendency following the introduction of the electric line is to show a falling off in the steam railway business; but I am speaking of the ultimate results, when the electric roads become as capilliaries, while the steam lines are the arteries.

PROFESSOR GILPATRICK: What progress is being made in freight facilities, for the carrying of coarse freight?

MR. KLINE: The companies are being compelled to meet the demand for such facilities. In the beginning they did not figure on that; but now promoters are figuring on that in the possibilities of their business and are figuring on preparing for it. Especially is this true in new lines where railways are not so easily built, and where the present population would not justify expectations of large passenger traffic. In these cases effort is made to stimulate freight business. The lines built in our part of the country were not built with that idea to any great extent. It followed of necessity and the equipment for such business is growing.

THE CHAIR: Regarding the question which Professor Gilpatrick asked, that was very thoroughly canvassed by the people I am building a couple of roads for, and had been gone over by them before, as the men were actually engaged in electric road building in three or four states. I was present when it was talked over and the question discussed with others who were engaged with them in the enterprise. They explained why they preferred a road to parallel a steam road, or practically parallel a steam railroad. This line we are building is composed of two branches, each being practically parallel with a steam railroad with big passenger business. There was a choice of two lines; one, by staying about two miles from the railroad, where a pike could have been followed, but bending to get through the central parts of the towns. But they considered it this way: when close to the steam railroad in the country, people are in the habit of travelling and you do not have to teach them to travel, and the local traffic will immediately change from the steam to the electric road. Then, as Mr. Kline says, the electric roads run through the centers of the towns. By doing this and mak-

ing it so much more convenient, it gathers all the travel from there. Another reason why it is better to parallel a steam road is that you are getting the people from both sides who have been in the habit of coming to the steam road to make journeys. If you go a mile or two miles to one side you will possibly get all on that side, but the people will not cross from the other side and go a mile or two to get to the electric road. But if close to the steam road, when the people from the whole territory which has been using the steam road come from either side, they will take the electric road. No doubt after many electric lines have been built practically parallel to the steam roads, lines will be built in new territory and in the course of a very few years will develop their business. But if we build the electric interurban roads practically parallel with the steam roads, we have good business from the first day we run. It will probably injure the business of the steam roads for a short time, but as Mr. Kline stated, there have been several examples of electric roads built between points where splendid steam road facilities already existed, and the general business of the steam roads, in passenger earnings, showed no decline. There is one such case right out of Dayton where the electric road is doing a good business, and I cannot see that there are any fewer people on the steam cars than there were seven or eight years ago. The Big Four road shows as heavy travel as ever it did. Many railroad people admit now that they were wrong in thinking that the electric roads would take all the passenger business. Until two or three years ago, it was the opinion that it was putting money into a thing which it was not likely would ever be gotten out, where an electric road was built to parallel a steam road; but since some of the roads have made reports and shown what can be done, it has been found that the opposite is true.

Take the Akron, Bedford & Cleveland road out of Cleveland, which is poorly built, with steep grades, nothing extra in alignment, between Cleveland and Akron, it is doing splendid business. Their report for 1901 made four or five days ago shows the operating expenses are only 56 percent. of the gross receipts; and they are parallel to a steam road and operating under disadvantages. Doubtless these roads which are being well built and will have a good traffic, will in a short time be operating for fifty percent of the gross receipts; and when they can do that in territory that does not have to be developed, it shows that the investors who built there looked ahead to better purposes than most people believed.

Professor Gilpatrick: Do I understand that a well managed electric railway is paying dividends?

The Chair: Paying interest on their bonds and many are paying dividends on stock which does not represent a dollar. Many roads are bonded for just about what it cost to build them—

that is, roads I am acquainted with; and then the stock represents the franchises, good will, enterprise and energy of the men who went into it in the first place; and if they get a dividend on that they are that much ahead.

PROFESSOR GILPATRICK: About three years ago a car company superintendent, on one of our railroads, remarked to me that not an electric road in Ohio or in the country was paying expenses, let alone dividends.

THE CHAIR: They are, tho'; I know that. Mr. Kline probably knows about those out of Dayton and some of them were built under disadvantageous circumstances.

MR. KLINE: One road only is not paying, and that is because two lines were built between the same points. The Southern Ohio is bonded for twice and a half the cost of construction, and its common stock is quoted at 76. It is bonded for fifty thousand dollars and it did not cost to exceed seventeen thousand dollars in original equipment. They have done much since in the way of equipment which might have been done in the original construction if the original contractors had not exhausted themselves for what there was in it, in "skinning" the job. There is a case which surely shows that these lines are payers. The new line just completed in October, the Dayton & Northern, about parallel to the interurban steam road, is paying five per cent. on the money invested by stockholders, and is operating under adverse circumstances as to terminal facilities in Dayton, the line ending fully a quarter of a mile from the center of the town.

PROFESSOR GILPATRICK: Are you, Mr. President, (I am not seeking to pry into any business secrets, however) in any of the enterprises with which you are connected proposing to introduce sleeping car service?

THE CHAIR: No; the lines we are building are too short for that; but while the Everett-Moore Syndicate were at work in Northern Ohio they were expecting to do that between Cleveland and Detroit. Since the trouble they have had financially, they have made public the earnings of their roads, and we see from the papers their embarrassment was caused by investing a great amount of money in telephone companies; and strong effort is being made (we don't know whether it will be successful yet) of cutting this Cleveland-Detroit line up into small pieces and selling it out to different ones. But from what I saw in the paper yesterday and the day before, they are trying to save it intact by selling the railways in Detroit which they own. If they sell with traffic arrangements to get into Detroit, they could still complete the through lines with sleeping cars as they expected to. In their report, published two or three months ago, on none of these roads reported did it take to exceed 66 per cent. of the gross receipts to operate the road, and every one was more than paying interest on bonds. They are all conducted as

purely passenger roads. The only freight business they are doing now is carrying package and express matter; but they proposed when it was all connected together to build a kind of freight car of their own to handle heavier freight, and to go into the business, also, of interchanging with steam roads, switching cars and hauling short distances. They are already doing that to some extent at Lorain with the Cleveland & Lorain road. There were many summer residences built last year in that territory and all the material was hauled on the electric road by transfer from the Lake Shore road.

PROFESSOR GILPATRICK: This sleeping car project has been suggested between Cleveland and Cincinnati, has it not?

THE CHAIR: That has been talked of through the Pomeroy-Mandelbaum Syndicate; but the Everett-Moore Syndicate has no connection through the state. But the Pomeroy-Mandelbaum Syndicate is working for such connection. The first plans made for the sleeping car project were the plans of the Everett-Moore Syndicate to put sleeping cars between Cleveland and Detroit, making a one night trip by the way of Toledo.

A Concrete Foundation Built at Youngstown, O.

J. B. STRAWN, SALEM, OHIO.

October 14, 1901, the writer was placed in charge of the work of constructing foundation walls for a building to be erected on the site of one destroyed by lightning a short time previous. Full and very complete drawings were furnished by the architect employed. Every detail was given, as was also the kinds of material, manner of construction and quality of work were fully set forth in the accompanying specifications.

After going over the plans and specifications with the general manager of the firm, (who was one of the Company having the work done) and after a full understanding was arrived at as regards the work in general, the writer was *turned loose,* with full authority — to hire men, order materials, tools, supplies of every kind needed in the prosecution of the work: — that the pay-roll be sent in each week, and the money would be sent back with which to pay the men.

The only injunction given was, "Use your own judgment in all matters."

Men and teams were secured to clear off the remnants of the destroyed building, and, to get things in readiness for work on the foundations.

A force of twenty-five men was soon secured, — principally, Hungarian Slavs; one of whom could speak fairly good English;

who acted as interpreter, when one was needed. This man was requested to bring in as many of his countrymen as he could get, who were good men to work, and they would have steady work for a month or, possibly more. It would be difficult to find a like number of men who were so efficient, prompt and faithful, as this man got. Only one Slav was discharged, while three residents of the place were discharged during the continuance of the work. The man who acted as interpreter, was a good all-around man, who had done considerable work mixing concrete, and was helpful in seeing that there was always something for every man to do, and that there was a man for every place. During the entire time of constructing the work there was not a man who had to wait for ten minutes for a job. The interpreter would look after the workmen when the engineer might be, for the moment, otherwise engaged.

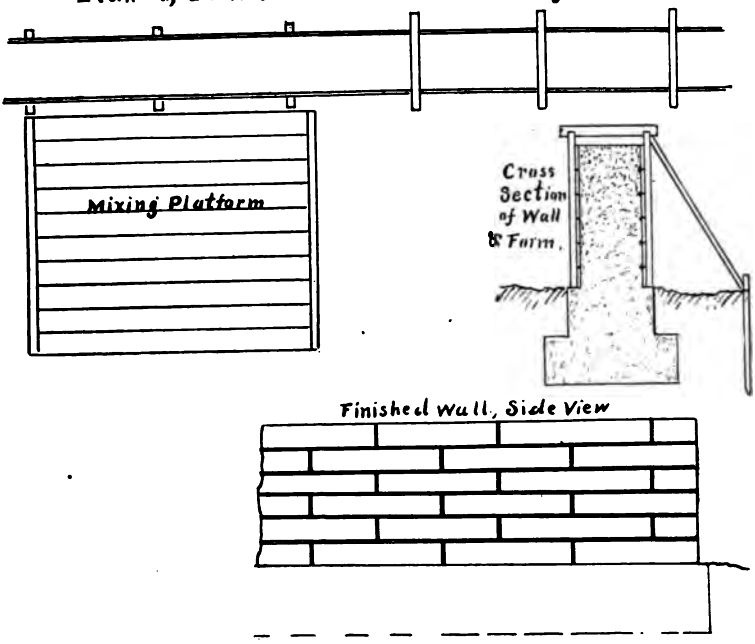
The architect's specifications called for a footing course for all walls and piers to be four feet wide and one foot thick; and, for all walls above the footing course to be 2 feet 6 inches thick throughout. All piers above footing course to be 2 x 2 feet, and to be built up to a level with top of walls.

In excavating for footing courses, it was found necessary to make the footing course, in places as much as 6 feet wide and the excavation was, in places, carried down as much as 6 feet below present surface of ground.

Where the ground would permit of making a fairly uniform vertical trench, no planking was used to hold the concrete in place; but, was deposited and tamped over the full width of the excavation, to a depth of from one foot to three feet in depth. The footing course was varied both in width and in thickness by reason of the character of the ground. The concrete work was brought up to an elevation of 6 feet below the elevation designated for the top of the finished wall: at which point the concrete work is 3 feet 6 inches wide. Upon this base for the principal wall the forms were constructed in which to deposit the concrete for the exterior walls. The forms were built as follows: The studding or posts were 4 by 4 inches by 7 feet long, seasoned pine, each pair of posts had a 4 x 4 inch cap, gained in $1\frac{1}{2}$ inches, which was spiked to the posts which were 2 feet 10 inches apart: this permitted 2 inch plank to be used for both sides of the wall, which was 2 feet 6 inches thick. The planks used for the outside faces of the walls were surfaced on one side. The plank used for inside of walls were not surfaced. The plank were 2 x 10 inches wide and 16 feet long. The posts for the frame work of the forms were spaced 5 feet 4 inches apart, giving three posts or, bents, to each 16 feet. The planks were kept apart about a quarter of an inch to allow for swelling of the wood, and for adjusting your forms, as there will always be a little variation in the width of lumber. The better way in

building the forms will be to set your end posts with caps spiked on (not too solid), for these caps must be knocked off on moving the forms. After the end bents are set up and stayed in place, next set the other bents to line which will be on the side of the bent away from the lumber pile. The bents will all be stayed with stay lath just 2 feet 10 inches between inside of posts; plumb your posts and see that the bottoms are well secured in place. The posts should be long enough to admit of about 6 inches between under side of cap and top of wall: where the planks for both outside of wall and inside should be level; then the top of your wall can be *struck off* same as a sidewalk.

Plan of Form for Concrete Walls at Youngstown, O.



J. B Strawn Engineer
Salem, O.

After you have set your frame work and stayed it firmly, set your level at a point where you can, if possible, have every post marked for exact height of wall. From these marks measure down, marking the joints between planks: as stated above. Don't forget to leave room for expansion of your plank. If you are using "dry" concrete mix, which requires heavier ramming than the "wet" mix, it will be well to use one-half inch dowel pins about 3 inches long of round iron to keep the plank firmly in place, inserting them in the edges of adjacent planks midway between posts. The plank should be all of same length and

for a considerable time, but now it is used for walls, partitions, floors and roofs of finest structures.

Thomas Potter, in "Cement," has an article on Concrete as a building material in England. In closing his communication he says. "At the present time concrete is rapidly coming into use for engineering construction, and possibly it is better adapted for work of this character than for domestic and public buildings, *floors* and *roofs excepted;* but after having lived in a concrete house for over twenty years, the writer can only say that for even temperature, freedom from damp and other essentials for domestic buildings, give me concrete walls and floors before any others."

"There has just been completed probably the most important building, in this country, composed entirely of cement concrete. It is located in Mineola, Long Island,— The Nassau County Court House.

"The general dimensions of the building are 75 x 95 feet. It is two stories, and measures 65 feet to apex of the dome. The building is practically an immense rock, cut and dressed with architectural ornaments on the exterior and mined inside in the form of rooms." "Cement" for Jan. '02.

PROCEEDINGS

OF

Twenty-third Annual Meeting

OF THE

Ohio Society of Surveyors and Civil Engineers

Columbus, Ohio, January 21-22, 1902.

(REPORTED BY MRS. BENIGNA G. KALB.)

First Session.

TUESDAY MORNING, January 21, 10 o'clock.

The Twenty-third Annual Meeting of the Ohio Society of Surveyors and Civil Engineers was called to order by the President, in the Great Southern Hotel, at ten o'clock Tuesday morning, with thirteen memberes present. The meeting scheduled on the program for Monday evening was not held owing to non-arrival of the members.

THE CHAIR: As we had no meeting last night, we will take up the program for that session, or that part which is ready for presentation. We will first hear the report of the Secretary-Treasurer.

Mr. Cellarius presented his reports (Printed following the "Proceedings.")

THE CHAIR: You have heard the reports of the Secretary-Treasurer: what will you do with them?

On motion of Mr. White, reports just read were referred to the Trustees.

THE CHAIR: The first paper is one on "Paving a County Road," by Sam Huston, Steubenville. His paper is in the hands of Professor Brown who is not present, so we will have to pass that. Following that is the report of the Committee on Public Highways. Mr. Evers expected to be here until yesterday, but in a letter states that he will not be able to be here on

account of sickness. He sends his report, however, which includes the specifications used in Cuyahoga County. I will read you his report and the specifications will be published. The chair read Mr. Evers' report. (Printed following the "Proceedings.")

THE CHAIR: If there is any other county which any of the members know of using or talking of using the law, we will be glad to hear of it. Our county talked some of using the law but nothing was done. I did not know until today, in reading this report, that the law had been carried up and declared all right. They had this carried through the courts so as to know whether it was constitutional before beginning work under it.

We will now take up the program printed for this morning. As it is customary for the president, I will have to make an address, I suppose. (President's address printed with "Papers and Discussions" ante.)

THE CHAIR: I believe the gentlemen who were to read the next two papers are neither of them here, therefore we will have the report of the Committee on Civil Engineering.

MR. E. A. KEMMLER: On receiving your communication, I at once wrote to all other members of the committee but have received responses from none except Mr. Dillon of Hamilton, Ohio, who sent me a paper. I myself have prepared a few notes which I expect to use in formulating a report. These are but random notes picked up here and there, but if you care to hear them I will read what I have prepared after reading Mr. Dillon's paper. (Both papers printed following the "Proceedings.")

THE CHAIR: Has anyone anything to offer upon the questions spoken of in these papers?

Next on the program is the Report of Committee on Drainage, but Mr. Fraker, the Chairman of that committee is not here. Has he been heard from?

THE SECRETARY: No; I have heard nothing from him.

THE CHAIR: We will pass that, then; and that completes the program for this morning, unless it is thought desirable that we take up some of the afternoon's program at this time.

I will appoint as Nominating Committee, Messrs. Kemmler, White and Baird.

On motion meeting adjourned until 2:00 P. M. same day.

Second Session.

TUESDAY AFTERNOON, January 21, 2 o'clock.

THE CHAIR: The Society will please come to order. I am glad to see that there are more present than there were this morning. I noticed this morning that there were just thirteen present and concluded that was not starting out very well.

The first paper to which we will listen will be one on "Asphalt Repairs in Columbus, Ohio," by E. A. Kemmler of the City Engineer's Department. (Printed with "Papers and Discussions, ante.)

THE CHAIR: We will now have a paper on "Designing of Riveted Connections," by Professor W. H. Boughton, Granville. (Printed with "Papers and Discussions" ante.)

No desire being evidenced for a discussion of Professor Boughton's paper, Professor Brown was asked to read the paper of Sam Huston, Steubenville, "Paving a County Road," which he did after stating that Mr. Huston was very sorry not to have been able to be present, as he had counted on doing until called away upon important business at the last moment. (Printed with "Papers and Discussions" ante.)

THE CHAIR: We will now hear the paper of F. L. Niederheiser, Ashland, on "The Improved Roads of Ashland County." (Printed with "Papers and Discussions" ante.)

PROFESSOR BROWN: If you are through with your program, before adjournment, I have a little matter in regard to the topographical survey on which I would like to talk for five or ten minutes.

THE CHAIR: There is one other report which I forgot about that is here, and as it is printed on the typewriter and easy to read, I will read this report. It is the report of the Committee on Land Surveying, which Mr. Gordon sent in. That will clean up everything except that which has been reserved for to-morrow. Mr. Gordon's report was read by the Chair. (Printed following the "Proceedings.")

THE CHAIR: Mr. Gordon touches on one question we had up two years ago, and that is the question of having all descriptions checked by the county surveyor and endorsed by them as correct or incorrect and a record kept thereof. That bill was introduced by Mr. ——— at the last session of the legislature and ably championed by him and others, but failed to pass by two votes. I understand he expects to introduce it again, with one or two objectionable features eliminated. I think it will have a better chance now to pass than it did last session, but I do not believe the three of us who spent so much time lobbying for it before have the time now.

That completes all before us, Professor Brown, if you have something to present.

Prof. Brown made an extempore address on the work of the United States Geological Survey. (Printed with "Papers and Discussions").

THE CHAIR: There are only two members of the Board of Trustees present, and as the Board must pass upon the report of Secretary and Treasurer, as well as applications for membership, I will appoint substitutes to fill the vacancies. Professor

Brown and Mr. White of the Board being present, I will appoint as substitutes for the three absent, Professor Gilpatrick, Messrs. Niederheiser and Seitz.

The program calls for election of officers at this session. Is the Nominating Committee ready to report, or will you postpone that until tomorrow morning?

MR. KEMMLER: We were laboring under the impression that officers would not be elected until tomorrow and have had no meeting of the committee.

Upon motion of Professor Brown, meeting adjourned.

Third Session.

Tuesday evening the society was entertained at the hall of the Columbus Engineers' Club. Prof. C. E. Sherman gave an address on "Roadbuilding in the Yellowstone Park" and Mr. G. W. Lillie gave an address on "Some Features of Municipal Engineering Construction" dealing especially with sewer construction. Both these addresses were copiously illustrated with lantern slides. Mr. ——— Fowler read a paper on "Relative Advantages of the Panama and Nicaraguan Canal Routes."

The addresses and paper were not reported for publication.

Fourth Session.

WEDNESDAY MORNING, JANUARY 22, 10:00 A. M.

The last session opened with the President in the Chair and a larger attendance than at any previous session.

The Report of the Board of Trustees was presented, as follows:

"The Trustees of the Ohio Society of Surveyors and Civil Engineers beg leave to report as follows:

We have examined the report of the Treasurer, and find that the moneys received have been properly accounted for, and that the books balance.

We have examined the applications of the following persons, viz., Oliver C. Talbot, L. J. Riegler, and I. L. Stinebaugh, and recommend them for election as members.

Respectfully submitted,

HOMER C. WHITE,
C. N. BROWN,
D. W. SEITZ,
F. L. NIEDERHEISER,
J. L. GILPATRICK,
Board of Trustees."

On motion, the report of the Board of Trustees was received and ordered placed on file.

Moved by Professor Brown that the rules be suspended and the President be directed to cast the ballot of the Society for the proposed members recommended by the Board of Trustees.

(Seconded: carried.)

The ballot was so cast by the President and the gentlemen named were declared elected to membership.

MR. WHITE: A matter of change in our constitution was last year referred to the Board of Trustees, with instructions to report upon the same to the Society this year. It was thought desirable by Mr. Wilson, the member who made the motion, that the nominating committee should be abolished and officers nominated and voted upon in open meeting. The Trustees have discussed the matter and concluded that the constitution is all right as it is, and we therefore recommend that no change, as suggested, be made in Article IV, Section 3, of the Constitution.

THE CHAIR: This, of course, requires no action, as the Trustees recommend no change to be made, unless the Society desires to go on record as not desiring any change and sanctioning by vote the present method. It will be made part of the report of the Trustees and go on record as accepted, and so put upon the minutes.

We will now hear the report of the Committee on Nomination of officers.

Mr. Kemmler presented the following report:

Mr. President and Members of the Ohio Society of Surveyors and Civil Engineers:

Your Committee appointed for the purpose of nominating officers to serve during the ensuing year begs to report as follows: For President, F. L. Niederheiser; Vice President, Robert E. Kline; Secretary-Treasurer, W. H. Boughton. For Trustees: A. W. Jones, F. M. Lillie, J. L. Gilpatrick, R. K. DeMotte, I. L. Stinebaugh.

Respectfully submitted,

E. A. KEMMLER,
HOMER C. WHITE,
E. C. BAIRD.

Upon motion of Mr. Brown, seconded by Mr. White, the rules were suspended and the President instructed to cast the ballot of the Society for the officers named in the report of the Committee on Nominations.

The Chair announced that the ballot had been so cast and the officers named in the report of the Committee elected to serve during the coming year.

THE CHAIR: That, I believe, completes the business left from the previous sessions, with the exception of the paper of Mr. Strawn.

MR. BROWN: I would suggest that as Mr. Kline is present and several of the members must leave early yet desire to hear Mr. Kline's paper, that we have that now.

THE CHAIR: We will give attention to a paper on "Electric Railways Between Distant Terminals," by Mr. R. E. Kline, of Dayton. (Printed with "Papers and Discussions" ante.)

(Owing to the lateness of the hour, Mr. Strawn's paper was read by title, "A Heavy Concrete Foundation Wall in Youngstown, Ohio," and ordered published in the proceedings.)

Moved by Mr. White that a committee be appointed to draft resolutions upon the death of Mr. E. P. Dickey, late a member of the Society, and as it is too late for this committee to report to the Society before adjournment, that this report be prepared and sent to the Secretary for incorporation in the proceedings of this meeting.

(Seconded: carried.)

The following committee was named, in accordance with above resolution: Homer White, Professor Boughton and I. L. Stinebaugh.

There is one committee which has not yet reported, the Committee on Legislation, of which Mr. Kline is chairman.

MR. KLINE: I have been absent from all these meetings and have been unable to meet the other members of the Committee to prepare a formal report. There were some matters before us two years ago when I was a member of a special committee appointed at that time. One was the matter of securing the passage of a bill to require county surveyors to keep up the plats of the county. The matter was pretty thoroughly canvassed, and among surveyors a hearty support was given by a number, a luke-warm support by others, and some opposition developed among some surveyors because of a lack of appreciation of what the bill actually meant. It was considered a matter of importance that there be an office of records in the matter of plats in every county, and it was felt that no one was more competent or better qualified or in a better position to attend to this than the surveyor, and for the purpose of facilitating record work of any kind the advantages of that system were very apparent. After canvassing the surveyors with the result indicated, and taking the bill to the House with the recommendation of this organization that the bill be passed, a double effort was made there and the bill was defeated by a very close margin. I am just as positive now as I was at that time that the thing should be followed up and that there should be a bill passed requiring it. There are economical reasons for it as well as reasons facilitating the looking up of records. The fact that these records are necessarily kept up in periods of ten years when the decennial work requires it, and thereby costing a great deal more from the fact that the records become stale in ten years and it is harder to trace down

succession of transfers than if taken up as soon as made at the time that full information is attainable in the easiest possible way. The engineer or surveyor in the court house has, or should have, qualifications and equipment for service to the county which he is very infrequently called upon to perform. It is a feasible proposition, but I will say it is not an easy proposition to bring to a proper solution when it comes to tackling the legislature. That I know by the experience I had, although we only lacked two votes of the required number to pass it.

Another matter of importance before us at that time was the treatment of highways, and their construction and maintenance. The state has no systematized method of treatment of highways as other states have. We have in the state as many, or probably more highways in proportion to the size of the state than any other. We have the resources here for building good highways, in fact much money is spent injudiciously for this purpose from lack of a head. That matter was taken before the legislature and argued in every phase, and was likewise endorsed by this society. It passed the Senate, but in the house met the fate of the one previously spoken of. It was not even given a hearing before the house, but was dumped into a committee. The only objection was that it would entail the employment of some additional men, in appointment of the commission suggested. But it is true that enough money is wasted in the state of Ohio in our methods of working of roads to carry out the plan as outlined in an eminently satisfactory way, with engineers behind the plans: and in but a very few years the results would be so apparent that a greater expenditure would be easily attainable without the outlay of a dollar more than is wasted now under present methods. Since that time I have thought, as the objection to the bill was in the fact that it created a new position that we have in this state a Board of Public Works which might be employed. It is not as well fitted for this business as for the business it is appointed to look after (but probably just as well, as they haven't done much but prove an expense to the state), but if that board could be empowered to take up this question they would at least have some practical thing to do and the desired results would be attained without additional expense to the state. I am sincere in my opinion that something ought to be done, whether by the appointment of a commission or by empowering the Board of Public Works to take it up. The matter of highways is of more interest to the state than the canals which has its two boards and a great organization throughout the state, with but little to do and a great expense in excess of the income. If it could be done without additional expense to the state, by the state board already existing, it would be worth something at least. I would recommend, in case it were impossible to get a bill through creating a special commission, which would be the

best method, some law be passed empowering this board to take up the matter of highway construction. I think it would be entirely feasible to be taken up that way.

I think of no other items in the way of possible desirable legislation. I am very sorry I was unable to submit a written report of the Committee.

THE CHAIR: Do you know whether Mr. A———— is expecting to reintroduce the bill?

MR. KLINE: I was talking with him two or three weeks ago and he was fully convinced that this platting bill should become a law and would give his aid to such a bill as before.

THE CHAIR: Some of those who supported it best are still in the House, also the three who fought it. And with Mr. Judson in the Senate we would have a good deal more help than we had in the senate before.

In my opinion there never has been a legislature for years when we would have stood a better chance for a good fair hearing and getting such a bill through as now. But the Society has made two or three efforts and is discouraged. I know that when I first became a member of the Society three or four efforts were made to have an examining board created, which would be self-supporting, such as are in existence for examining candidates for the bar, practice of medicine, pharmacy, stationary engineers, and even the barbers, I understand, are to have one. Such a board is in accord with the spirit of the times, and with a proper bill creating a proper board, I believe such a law would be of great benefit to engineers and surveyors and to the public in general.

PROFESSOR GILPATRICK: I wonder if it would not be well to pass a resolution to bury that Board of Public Works in the canal. I would be in sympathy with that plan to give those men something to do besides spending time figuring how to hold their jobs as at present. I am interested in that suggestion and hope a committee will be named to look after that this year.

MR. KEMMLER: I had some thought myself along the lines suggested by Mr. Kline. In fact, last year, as my contribution to the report I made something of the same suggestion that the State Board of Public Works might be made to take up this subject whether it wants to or not by a law passed, and if the matter proved to be successful and the canals should finally be abandoned, all these men now engaged on canal work would simply transfer their positions to positions on road work and nobody would lose his job. In that way they might be convinced that this road question is one worthy of their attention.

I have been thinking this morning whether it would not be a good plan to instruct the legislative committee to prepare outlines of a number of bills, one on the road question, one on the keeping up of decennial plats, as suggested by Mr. Kline, another

providing for the examination of all descriptions in deeds by the county engineer. Those are three matters of great importance and ought to receive consideration. Then we might make the next meeting a meeting for legislative business. There is no hurry about these matters. When a project is ripe it will take hold of itself, and be more liable to be passed two years from now than it is now. Whenever the people are ready for the road question they will go after it themselves without being stirred up by a society of any kind. So we could make the next meeting one for legislative action principally. We have been here this year, hardly a committee; have had some good papers, but the most of the members will receive no benefit from the meeting except what they get by reading the report, six or eight months later. But if we make the next meeting a legislative meeting and notify all county surveyors, city engineers and engineers in general that we have some definite object in view for the next meeting, that we are going to meet to consider these bills, giving them outlines of the same, then we may possibly have some attendance at the next meeting and be ready for the legislature the year following.

At the present we have no bills prepared to start with, and the legislative committee will not have time to do anything; but it will have time to draft outlines of bills to be presented to the secretary, by him worked up and used for the next meeting.

That suggestion I made for the good of the Society as well as for the good of engineers in general.

THE CHAIR: There is one bill which would probably be better to be pushed at this session, but the others would be better deferred as Mr. Kemmler suggests. The bill of Mr. A——— was thoroughly gone over, objectionable features eliminated, one or two things added, and it could be pushed right ahead now with Mr. A———'s support. As to this matter of keeping up of decennial plats, I don't know as it needs an action of the Society, as it once endorsed the bill.

MR. KLINE: I move that the Legislative Committee take this matter in hand along the lines suggested by Mr. Kemmler, and furthermore assist the Secretary by their efforts to secure the attendance of surveyors and engineers of the state at the next meeting by calling attention to the fact of such possible business to be transacted and exciting an interest in that way.

The attendance should be increased and I believe this committee could assist the Secretary in accomplishing it.

Motion seconded by Mr. Kemmler. Carried.

Upon motion of Mr. Kline, meeting adjourned.

Report of Treasurer.

REPORT OF TREASURER.

Receipts.

Balance on hand	$9 99
Sale of reports	1 00
Dues and fees	209 00
Advertisements	117 38
Total	$337 37

Disbursements.

Printing, engraving, etc.	$193 40
Stamps	32 00
Freight, expressage and drayage	23 68
Stenographer	53 50
Hann & Adair, on account	25 00
Balance on hand	9 79
Total	$337 37

Due on printing 1899 report	$152 31
Due on printing 1901 report	146 94
Due from advertisers	188 50

Report of Committee on Public Highways.

WM. H. EVERS, CHAIRMAN.

I must apologize to my fellow-members on this committee for not communicating with them concerning the above report, but it was not until less than thirty days ago, that I was notified as to the membership of this committee.

I find upon careful inquiry that no county has taken advantage of the General Law passed two years ago by our legislature, for the improvement of State and County roads.

Our County Commissioners have always favored the proper surfacing of County roads, and about eight years ago, secured the passage of the so-called Pudney Road Law, which was later decared unconstitutional by the Supreme Court, but not until they had succeeded in improving about sixteen miles of roads.

So popular were these improvements that in 1900, Section 4637 of the Revised Statutes of Ohio was supplemented (see Ohio Laws, 94-366), which will improve all of our highways, on a basis providing equitable taxes, and special assessments according to benefits only, and to get a clear interpretation of the law, our Citizens' Protective Association made a test case of

some technical phase of the bill, and carried the case to the Circuit Court of Cuyahoga county.

Our Commissioners being so fortified levied a general tax of one-half mill, providing a fund approximating $90,000.00 per year.

With this fund as a nucleus, we have under way the following improvements, the work of one year. All work is done on Petition, signed by at least a majority of the foot frontage on any County or State road and the Commissioners may do any one, or all of the following:

1st. Cause the County Surveyor to establish a grade along the road.

2d. Cause said road to be widened, or altered to a width not exceeding 100 feet, as recommended by duly appointed Viewers.

3d. Grade, drain, curb, pave or macadamize said road.

The County Commissioners are constituted an assessing board, and have levied on the adjoining property of our various improvements, from 30% to 60% of the total cost of the same, according to benefits, paying the balance of the cost of the work out of the County Treasury.

Notice of assessments must be published three consecutive weeks, and all written objections are equalized by three disinterested property holders, appointed by the County Commissioners.

When the assessment is confirmed by the County Commissioners, the same is complete and final, and the County Auditor shall place the same on the tax duplicate, payable in ten annual installments, as other taxes.

When the amount of the first installment is paid in, the Commissioners are authorized to issue notes of the county for the balance of the expense of the improvement, and can then proceed to contract the work as may be subscribed by law.

SCHEDULE OF ROAD IMPROVEMENTS IN CUYAHOGA COUNTY FOR YEAR 1902.

	Length of Improvement.	Kind of Improvement.	Engineers Estimate.	Taxable to Property.	Payable by County.
Detroit St	3 miles	Grading, Draining, Curbing, Brick Paving or Asphalt	$116,600 00	$69,071 33	$47,528 67
Miles Ave	1½ "	Grading, Draining, Curbing and Brick Paving	51,000 00	34,937 75	17,062 25
Noble Road	2½ "	Grading, Draining, Curbing and Brick Paving	51,450 00	30,943 62	20,506 38
N. Woodland Rd	7 "	Grading and Planking	36,428 00	22,802 70	13,625 30
State Rd,	3½ "	Grading, Draining and Bituminous Macadam	76,460 00	34,535 67	41,924 33
Euclid Road	2¼ "	Grading and Draining	77,500 00	65,507 42	11,992 58
Kraft Hill	¼ "	Grading	1,510 00	380 00	1,130 00
Totals	20 miles		$410,948 00	$257,178 49	$153,769 51

General Specifications for the Improvement of Roads in Cuyahoga County, Ohio.

GENERAL SPECIFICATIONS.

GRADING AND SUB-GRADING.

The streets, including roadway, intersections, approaches and drains, shall be graded to such grades as shall be given by the Engineer in charge, and according to the cross sections on file at the office of the Board of Commissioners. All excess of excavation not needed in adjoining embankments must be hauled by the contractor to such points as directed by the Engineer, within one thousand (1,000) feet of the limits of said excavation.

Before laying the foundation, and after the curbstone has been set, the subgrade shall be well rolled with a roller weighing not less than seven (7) tons, until the subgrade conforms to the finished crown of the pavement.

After rolling and before placing any material on the roadway the grade shall be tested by the Engineer, and if any places are found higher than the subgrade line, such places shall be brought to the true grade, and if any places are found to be lower than the subgrade line, the depressions shall be filled with gravel at the contractor's expense, unless where spongy or soft material is encountered in the subgrade, the contractor shall remove the same upon the order of the Engineer, and such space shall be filled with gravel or broken stone for the price bid per cubic yard of broken stone furnished and laid.

The price bid per cubic yard of excavation in grading and subgrading shall include the excavation and removal of all earth of every kind, and all rock, shale, cinders or boulders, as no classification will be allowed under this contract; also the removal of all stumps and the grubbing out and removal of all underbrush and all trees three inches or less in diameter one foot above the ground.

EXCAVATION IN TRENCHES.

The contractor shall open trenches of such depth, width and cross section as indicated on plans, and no allowance will be made for additional widths, unless where ordered by the Engineer. Such surplus material excavated from trenches as indicated by the Engineer as not needed in back filling shall be removed by the contractor to such points as may be directed by the Engineer, within one thousand (1,000) feet of the place of excavation.

The price paid per cubic yard of excavation in trenches shall include the cost of all excavating and removal of surplus material, as specified above.

EMBANKMENTS.

All embankments required within the limits of the improvement shall be made with soil free from shale or other objectionable material. All embankments must be thoroughly compacted by rolling in six inch courses, and must be built up at least one foot above the finished grade of the road. All adjoining slope rights must be made 1½ to 1.

The price bid per cubic yard of embankment in grading shall be the entire cost to the county of furnishing all material, rolling and labor required to make the necessary fills and protecting slope rights.

DRAINS AND SEWER PIPE.

After trenches have been opened as above specified, the contractor shall place the drain tile or sewer pipe of the size ordered by the Engineer, with open joints upon two (2) inches of coarse, acceptable sand or gravel for French drains. He shall then completely fill said trench with screened slag or stone, free from all dust, and of a one (1) inch mesh, and carefully compact the same by hand tamping with a paver's rammer to the satisfaction of the Engineer in charge. All pipe must be equal to the first quality of Akron Vitrified Sewer Pipe and must be laid to the lines and grades given by the Engineer. The price bid per lineal foot of sewer pipe and specials furnished and laid shall include the cost of laying the same on a bed of sand or gravel as above, but all stone laid in French drain will be paid for according to the price bid per cubic yards.

CATCH BASINS.

Catch basins shall be built where directed, according to the attached plan. They must be built of hard sewer brick and mortar, composed of one part of Saylor's or Sandusky Portland Cement and two parts of clean, sharp sand. The price bid for each catch basin complete shall include the cost of all excavation and back filling and disposal of surplus material, and the furnishing of all necessary labor, brick, mortar, cover and traps as indicated on plan.

CONCRETE FOR FOUNDATION.

The concrete for foundation shall be either four (4) inches of Portland Cement concrete, or six (6) inches of Natural Cement concrete, at the option of the Board of Commissioners.

PREPARATION OF CONCRETE.

Natural Cement Concrete — Cement.

All cement must stand tests as follows:

Specific gravity, not less than 2.7, and shall leave a residue on a No. 50 sieve, not over 5 per cent.; on a No. 100 sieve, not over 15 per cent.; on a No. 200 sieve, not over 35 per cent.

Briquettes shall have one square inch of breaking section and must develop the following breaking strengths:

Sand Briquettes (1 of cement to 2 of sand by weight). Age, 7 days (1 day in air and 6 days in water);, strength, 75 pounds. Age, 28 days (1 day in air and 27 days in water); strength, 125 pounds.

Neat Briquettes: Age, 24 hours (in water after hard set); strength, 70 pounds. Age, 7 days (1 day in air and 6 days in water); strength, 130 pounds. Age, 28 days (1 day in air and 27 in water; strength, 200 pounds.

Sand.

All sand shall be coarse, sharp, silicious sand, free from loam, organic matter and other impurities. It shall pass a No. 10 standard testing sieve (10 meshes per lineal inch), and not less than 30 per cent. shall be retained upon a No. 30 sieve (30 meshes per lineal inch). It shall be stored upon the work upon suitable wooden platforms.

Stone or Slag.

All material for concrete shall be hard limestone or machine crushed slag acceptable to the Engineer. All stone or slag used for concrete shall be of a 1½ inch mesh, free from all dust and fine material. All stone or slag must be wetted before being mixed with the mortar.

Water.

All water used in the construction of this contract, or for the cement filling, concrete, or for keeping the same wet, must be obtained at the contractor's expense.

Portland Cement Concrete — Cement.

All cement must stand tests as follows:

Specific gravity, not less than 3.0, and shall leave a residue by weight on a No. 50 sieve, not over 1 per cent; on a No. 100 sieve, not over 10 per cent.; on a No. 200 sieve, not over 30 per cent.

It shall not contain over 4 per cent Magnesia (Mg. O.) and it shall not contain over 1.15 per cent. of Surphuric Anhydride (S. O3).

Briquettes shall have 1 square inch of breaking section, and must develop the following breaking strengths:

Neat Briquettes: Age, 24 hours (in water after hard set); strength, 125 pounds. Age, 7 days (1 day in air and 6 days in water); strength, 400 pounds. Age, 28 days (1 day in air and 27 days in water); strength, 550 pounds.

Sand Briquettes (1 of cement to 3 of sand): Age, 7 days (1 day in air and 6 days in water); strength 125 pounds. Age, 28 days (1 day in air and 27 days in water); strength 200 pounds.

Natural Cement concrete shall be composed of 1 part of natural cement, sand 2 parts and 4½ parts stone, and Portland Cement concrete shall be composed of 1 part of cement, sand 3 parts and 6 parts of stone. All concrete may be machine mixed but the method used for determining the volume of the various ingredients therefor must be approved by the Engineer, and the concrete must be deposited in the work in such a manner as not to cause a separation of the stone from the mortar. Should such separation take place the concrete must be turned by hand in the subgrade upon a tight platform, until the mortar is evenly incorporated with the stone, and then shoveled directly to the points of final deposit and thoroughly rammed in place. Between the 1st of June and the 15th of September all concrete laid, shall be kept throughout wetted between 10 A. M. and 4 P. M. of each day until the Engineer declares it in condition to receive the sand cushion or binder course.

BRICK COLVERTS. — EXCAVATIONS.

The contractor shall excavate the trench a uniform width at least two feet wider than the outer diameter of the sewer. The excavation made, must be protected where necessary by suitable sheet piling and bracing, in a manner satisfactory to the Engineer. All sheeting and bracing to be furnished by the contractor and paid for per cubic yard of excavation in trenches and subgrades, which price will also include the removal of all surface and storm water that may be encountered, so that all brick masonry can be laid in air, and all water kept from same until the mortar has sufficiently hardened, so as not to be injured by running or standing water.

BACK FILLING.

Before removing the centers of the newly built arch, the contractor shall fill and thoroughly compact earth over the same to a depth of at least two feet above the crown of the arch. All back filling to be thoroughly compacted in one foot courses, all to be done at the price bid per cubic yard of back filling over culverts.

SHALE BRICK MASONRY.

The inner ring of the culvert shall be lined with shale brick, vitrified all the way through, of an absorption not to exceed 6 per cent. by weight laid in full beds and joints of mortar, composed of two parts of clean, sharp, acceptable sand, and one part of Saylor's or Sandusky Portland cement, the beds and joints to be made in one operation as the bricks are laid, face joints not to exceed one-fourth inch.

The price bid per cubic yard of Shale Brick Masonry shall include the cost of all labor, brick and mortar required to lay the inner ring as specified above.

SEWER BRICK MASONRY.

The wing walls, and outer rings of the culvert shall be built of hard burned sewer brick of standard size, of an absorption of water not to exceed 15 per cent. by weight, laid with full beds, and joints of mortar composed as specified above for the concrete. The price bid per cubic yard of Sewer Brick Masonry shall include the cost of all brick, mortar, inverts and centers required to build the culvert according to plan.

MANHOLES.

All manholes shall be built of the design as indicated on plan, of hard burned sewer brick of standard size, and mortar as specified for Shale Brick Masonry.

The price bid for each Manhole complete, shall include the cost of all brick, mortar, iron steps, iron cover, and labor required.

TREES.

All trees more than three inches in diameter measured one foot above the ground ordered removed and destroyed, shall be paid for at the price bid per tree grubbed out and destroyed.

CURBING.

All old curbing found within the limits of the work shall be taken up and removed to such points as the Engineer shall direct.

Curbing to be set wherever ordered and to be of the best quality of Berea, Amherst or East Cleveland white sand stone 5 inches thick and not less than 20 inches deep, or less than 4 feet long; stones to be flat tool or crandle dressed to a straight line, and to a ¼ inch bevel in five inches, and to a uniform thickness of 5 inches, and brought to a straight line on top and face by the use of a straight edge. Stones to be taken out of wind and to be cut with a ¾ inch flat tool, draught on upper edge of

face, stones to be set with close joints, at least 10 inches on ends and face not more than $1\frac{1}{2}$ inches slack at the bottom on each end, to the true line and grade of the street and settled into place with a paver's rammer, and the earth in front and rear tamped with a heavy hand tamper to the full depth of the stones. Medina curbing to be jointed and set as directed around curves and corners at same price as for straight work. Curb to be dropped 4 inches at all driveways, unless otherwise ordered.

All stone must be set with closed joints upon four inches of slag or limestone as specified above for French drains to the true line and grade of the street with six inches of slag or limestone as specified for French drains behind the curb and settled into place with a heavy paver's rammer up to within four inches of the top of the curb. Curb to be set and jointed around curves at same price as for straight work.

The price bid per lineal foot of 5 inch by 20 inch curbing set, shall be the entire cost of all trenching, back filling, dressing and setting of curbing as specified above.

BRICK PAVING.

The street including all intersections and approaches shall be paved with acceptable brick of a uniform size, at least $3\frac{1}{2}$ inches by $8\frac{1}{2}$ inches by 4 inches. Brick must be made with slight projections on the sides and shall be laid on edge, in courses as directed by the Engineer in charge, upon a sand cushion at least one inch in thickness. Adjoining courses must break joints at least three inches and every fifth course must be straightened by using a wooden bar and sledge hammer. After the paving has been laid, it shall be rolled by a roller weighing at least 7 tons, and then rammed with the hand tamper as specified above and brought to the true crown and grade of the road by the use of a straight edge.

CEMENT FILLING.

All joints must be filled to their full depth by a mixture composed of one part either Saylor's or Sandusky Portland cement, and one part clean, sharp lake sand of an approved quality. The cement and sand to be thoroughly mixed dry, in a proper box, and then only enough water shall be added to make the grout of a fluidity when thoroughly stirred, satisfactory to the Engineer. After the pavement has been thoroughlv wet, it shall receive at least two separate applications of the mixture, quickly swept into the joints of the pavement, until the joints shall remain full to the top. Two hours after the grout filling the pavement shall be covered with a light dressing of clean sand, which with all other accumulations shall be removed by the contractor at his own expense at such time as the county

shall direct. The contractor to be liable for all damages which may be incurred by wagon traffic or in any other way.

GUARANTEE FUND.

All work done under this contract shall be guaranteed by the contractor, and there will be retained by the county from the amount due upon the final or from any previous estimates, at the option of the county, a sum of money equal to ten (10) per cent. of the total amount of work done under this contract, which amount shall be retained as a guarantee upon the part of the contractor that the workmanship and materials furnished under these specifications are in all respects as herein provided, and that the improvement will remain in good and perfect condition for and during the period of five years, from and after the day of the payment of the final estimate under these specifications. The contractor shall also preserve the wearing surface in good condition acceptable to the Board of Commissioners during a period of five years beginning at the expiration of the above guarantee and covering a period of five years thereafter at the price bid per square yard per year.

WHERE DEPOSITED.

Said amount retained shall be deposited by, and in the name of .... together with a statement of the intent and purpose thereof, with such bank as the .... may by resolution declare, and all interest and dividends accruing thereon, shall be considered as a part thereof; all of which shall be used in the manner hereinafter set forth.

FAILURE TO MAKE REPAIRS.

If at any time said contractor shall, within five days after receiving notice from the .... so to do, fail or neglect to make repairs to the improvement or any part thereof, as herein provided, then said .... may without further notice proceed to make such repairs or cause the same to be done, and the cost of this work together with the cost of all inspection that .... deem necessary in connection therewith, shall be charged to and deducted from the guarantee fund

RETURN OF GUARANTEE FUND.

In case the contractor shall make all repairs and renewals which may become necessary under this contract and guarantee, and leave said improvement in good and perfect condition, acceptable to the .... at the expiration of said guarantee, then upon the expiration of the term of guarantee, said amount on deposit with all accrued interest thereon, less

any expenses which the county may have incurred in connection therewith, shall be paid to said contractor as full payment of any balance due on said contract and improvement as herein provided.

— 1902 —

Report of Committee on Civil Engineering.

BY L. A. DILLON.

To the Ohio Society of Civil Engineers and Surveyors:

As a prelude to the report of the committee on civil engineering it is the desire of this committee to call the attention of the society to the fact that owing to the wonderful advancement in our profession during the 19th century we feel incapable of dealing properly with a subject so broad in its meaning and covering so many departments of industrial life. By a gradual system of evolution the civil engineer is now a component of various subdivisions of industrial development, and these components in the aggregate, are supposed to furnish the civil engineer. He is supposed to be conversant with every thing that scientifically transpires in the universe. He is, or should be, a combination of the mechanical, the electrical, the mining, the sanitary, the hydraulic, the municipal and landscape engineer; a bridge and structural iron expert; an authority on all kinds of cement, stone and paving material and a past grand master in mathematics. While these subdivisions do not embrace all necessary for the engineer no doubt the members of the society will complete the remainder from personal experiences. While it is necessary for him to acquaint himself with the above subdivisions it is also necessary for the engineer to invade the ranks of other professions and should be an authority on many questions of law, medicine (particularly as to the dissemination of disease by impure water, filth, etc., and the prevention thereof), geology and chemistry. We believe that no other profession requires so wide a range of knowledge and we therefore recommend that in the future this committee be subdivided into sections so that separate reports can be obtained and better results secured than from one general committee dealing with the subject as a whole.

At the close of the 19th century practically and looking backward we notice the wonderful development that has not only taken place in our profession but in all other branches of industrial and commercial development and ask "where will it cease?" It seems only bounded by the ingenuity and intrepedity of man and in the case of the "Yankee" therefore it has no limits and the end cannot be foreseen.

The improvements made in the appliances used by the engineer are something wonderful and would be a fit subject for an article alone. The compass is obselete, and the transit-theodolite with its numerous attachments giving accuracy and completeness has taken its place. The heavy and cumbersome chain and links has been superseded by the convenient tape with its various attachments for accuracy.

The civil engineer also is now in such intimate relations with the mechanical and electrical engineer that the lines defining each are very obscure. In connection with the mechanical engineer and the industry and intelligence of the American mechanic we are enabled to produce and deliver material with such rapidity and economy that the old world stands aghast and trembles for its future commercial welfare. The American engineer has, by the scientific application of his knowledge, the ingenious use of machinery and the skill of the mechanic, successfully competed with the production of European countries so that at the present time, bridges, locomotives, structural iron and machinery of all descriptions are now being exported from this country to the domains of Great Britain, Germany, France and other foreign countries, and a large and increasing trade is with our South American sisters. This superiority of the American people has so aroused European countries that the rulers themselves are personally investigating the reasons thereof and seek a remedy therefore. This committee desire to impress upon the members the importance of his profession and request them to at all time seek the advancement of its interests in the proper direction. We are prime factors in the development of the world. There no doubt has been times in the career of every one of us when we felt that our efforts were not properly appreciated or our motives misconstrued, but an honest straightforward course cannot fail but win eventually. At the present time the civil engineer is consulted by the capitalist ere he invests his money and the decision of the engineer is final with him and upon that decision rests vast expenditures of money and the development of communities.

Inasmuch as the committee on civil engineering is of many years standing, no doubt the society has been fully informed as to historical data far more completely and intelligently no doubt than could be done at the hands of this committee. Therefore coming down to the present and future, and looking back to profit from lessons of experience, should be the aim of all members. The past year has witnessed much of interest. The able representatives of this profession in the employ of the government has done more for Havana in the prevention of death and disease than has been done through any other agency prior to 1752. The American manufacturer has vanquished his European competitor in the open market despite the fact that our employes are better paid. Feats of daring in structural iron and cement work

are performed that a few years ago would have been considered impracticable, but nothing is done without accurate data and ever confident that results will be absolute and satisfactory. Electrical power transmission with heavy voltage and distance that seems incredible marks a distinct stride in electrical progression. The mammoth subway construction with the difficulties encountered in New York city is one of the wonders of the age. Foundation construction and the design of structural iron work for "sky scrapers" has given opportunity for great skill and ingenuity. The sub-marine boat and the dirigible balloon now seem practicable and with their complements of war and the aid of chemistry render it possible to destroy the greatest battle ships and vast armies at one fell blow and will be an important factor in establishing peace universal without the necessity of conventions. The ship canal now before congress and passed by the house by a practically unanimous vote will be our greatest factor in commercial development and a powerful aid in time of war. Wireless telegraphy is now on the threshold of the world seeking admittance and in the hands of the wizard Marconi success seems certain and its possibilities cannot here be estimated.

Notwithstanding our wonderful progress however, there are numerous unsolved problems that confront us and a step toward their solution would be the formation of special committees by this society with the idea of reporting to us the results of their investigations. Perhaps to us the most important fact is (while it may not require a committee to investigate) is that our efforts are not sufficiently appreciated or protected. We spend continual years of study in attaining knowledge and applying it to the public good. Our motives are criticized when not in touch with the powers that be or when our opinions do not respond to the popular chord. Unfortunately many of us secure our living by political preferment and while at all times open to just criticism we are frequently made the victim of partisan malice despite our best efforts.

For the municipal engineer much confronts him. The growth of American cities has been something wonderful. He is supposed to know everything from a hand saw to a transit. To him we must look for our municipal development. He must carefully consider all the phases of municipal life that apply to his profession. Upon his judgment and discretion depends the expenditure of much money judiciously or uselessly. The questions of sewage and garbage disposal, water supply, grade crossings of railroads, effects of the single trolley on water and gas mains and the regulation of electric roads are all of vital importance. The greatest problem perhaps is the best, most durable, healthful and economical street pavement.

To the general engineer attention is called to the wonderful advancement in all industrial development particularly in the

mechanical and electrical world to which we are closely allied. Urban and interurban roads are on all the main streets and roads of this and other states. Their inception and construction have called into play the greatest constructive and executive ability of the civil engineer and so far as inter-urban roads are concerned they are still in their infancy. The uses of structural iron and cement has been daring but with new appliances and discoveries it is possible to foresee their future uses in the hands of an ingenious investigator. The growth of the country points out to railroads the necessity of better track construction to insure safety and speed, even though the changes be in cities and enormous sub-ways be necessary to relieve the congestion of traffic. Experience has demonstrated to electrical companies the desirability of a multiplicity of wires in cable form and laid in subways, rendering them less liable to disturbance by the elements and beautifying the city by the removal of unsightly poles. Mammoth irrigation plants for the reclamation of arid plains into fertile fields is a great feature in our western country. The tendency of State Boards of Health to prevent the sewage pollution of streams and water supply has called into requisition a scientific disposal of sewage and these same boards in the interests of public health further and promote so far as possible the destruction of garbage.

In conclusion, while the close of the 19th century gives evidence on every hand of the wonderful advance of the world in every way and largely through the instrumentality of civil engineers, there will be still further advancements even in the next decade that are not dreamed of in our philosophy. To meet these demands will require our greatest ability and the earnest co-operation of all engineers working for one objective — the common good.

BY MR. E. A. KEMMLER.

An American definition of A Civil Engineer is: "A man who can do well for one dollar what anybody can do somehow for double the money."

Civil Engineering then, from this point of view may be said to be the art of making a dollar do the greatest possible amount of work for its owner.

Civil Engineers of the past have not always shown the proper regard for the relation between the cost and earning power of works designed by them, to some extent perhaps, because the Engineers themselves were not financially interested in the projects, and because they wanted these works to remain as monuments to their skill, no matter what they cost.

Through such lack of consideration for the business end of a project, works have been constructed, which could now be replaced by substitutes, equally as good, for one-half the money.

This is not Civil Engineering in the true sense of the word. The Engineer of today must be a man of business as well as a technologist. One of the first considerations which claims his attention is that of the resources of the company or corporation to which he is selling his time and skill.

A city of 50,000 inhabitants, and a tax duplicate of $10,000,000 could hardly afford a water-works system, including a pumping station built of marble on an equally expensive site, while with a duplicate ten times as large, such a station might be erected with the greatest propriety.

The past year has been productive of a number of changes in the direction of better engineering from this point of view.

The agitation for better roads has disclosed the fact that many of the highways constructed in the past have been too expensive to become popular. In order to convince the land-owners that macadamised roads would be to their advantage you must show them that they will be good investments. Roads which cost $15,000 per mile are a poor investment in any country, but reduce the cost to $500 or $1,000 per mile, and make them serve the same purpose, and you will appeal with some measure of success to those who pay the freight. Roads are being built in New Jersey and Massachusetts under State Aid which are said to fill all the requirements, with road metal but 3-5 inches thick.

In the line of street paving there has also been some advance in this direction. Warren's tar-macadam and Whinery's asphalt-macadam, substitutes for asphalt roadways, are claimed to be equal to, and in some respects superior to, the standard asphalt pavements of today, with the cost of the wearing surface reduced one-h-alf. Warren's pavement has been laid in some quantities in northern latitudes during the year, and appears to meet the popular demand.

In the construction of impounding dams there has been a decided departure from the time honored methods, in the case of the Redridge Dam across Salmon Trout River in Northern Michigan. The work was commenced in June, 1900, and is now nearing completion. It is 1006 feet long and has a maximum height of 74 feet. It has a gravity section, the lower part being concrete, the upper of steel trusses and plates.

It borders almost on Engineering heresy to offer any critisism on the present standard solid dam section, or to depart from the same in design and construction. And yet the solid masonry dam is not above criticism, at least, as heretofore constructed. Four such dams have failed within the last six weeks. The failure of the Austin dam is still fresh in our memory. The defect of the solid masonry dam is the excessive quantity of

good material, doing little work, so that while the nominal factor of safety may be three, it ranges all the way from 1 to 1000, while the material is all of the same strength. A section so designed that every part receives as nearly as practicable its proportionate share of stress seems to be demanded by the spirit of the times, for it would be just as efficient as the usual section, and more economical.

The Chicago, Milwaukee & St. Paul Railway has during the past year used a burnt soil ballast, which they claim is equal to broken limestone or slag, and better than gravel, prepared at a cost of 32 cents per cubic yard.

In the construction of sewage filters money has been saved in a number of instances, by using furnace clinker or locomotive cinders instead of sand. Whether this has been in line of true economy or not, is too early to decide. It is true that some of the coke filters used in England during the past few years have clogged up, or disintegrated, but the same has been true of a number of sand filters.

There has grown a decided sentiment against the use of septic tanks in England during the year. The sludge problem seems not to have been disposed of, as was at first expected. While it was reported at first that the tanks annihilated everything organic, even rubber boots, recent results indicate that less than one-half of the sludge is eliminated.

We note the growing sentiment in favor of national aid, for irrigation in the arid lands. Congress is expected to act favorably upon this proposition during the present term.

What has been reported to be an unlimited quantity of mineral oil of asphaltic base has been discovered in Texas, promising to revolutionize the cost of asphalt paving, and fuel in a local way.

The passage of a bill for the construction of an inter-oceanic canal across the isthmus seems now assured. It is to be hoped that no false sentiment will control the sèlection of the route. At present the Panama route seems to be in the ascendency, and if no legal international obstacles are encountered, it is possible that this route will finally be adopted.

As far as we have been able to learn no Civil Engineers are at present out of employment, and the coming season promises greater activity than ever before.

E. A. Kemmler,
H. M. Gates,
L. A. Dillon,
C. A. Judsno,
J. A. Hanlon.
Committee.

Report of Committee on Land Surveying.

C. M. GORDON, CHAIRMAN.

Mr. President and Brother Members:

We have all, at some time, had trouble in ascertaining the correct line of Land Surveys and establishing the exact corners of the Land in dispute. In such cases the Surveyor is placed in the same position between the adjoining Land Owners, as the Judge is before the witnesses and then finally chooses according to the field notes that have been handed down from the first Survey. If the Line surveyed coincides with the views of the interested Parties, they are all well satisfied. If not they will take the matter to Court and will settle their differences by calling witnesses to the supposed Line that was regarded as a correct one and in a majority of cases the Judge will decide according to the occupancy of the disputed territory.

The County Surveyor's Office should be one of record and he should examine each and every deed of Land before the Auditor should transfer the same for record and if found correct, he should endorse the same.

A true description of Land is one which gives the boundaries, so as to plat and join all the corners correctly. The angles should prove and the acreage so recorded should correspond with the acreage given in the old record. If surveyed by an unauthorized Surveyor, the County Surveyor should calculate the acreage and certify to the amount, tne Township, number of Survey and in whose name patented. Water courses should be given in each description for each tract of land including the number of said tract, as it has been subdivided from the Original Grant. If found accurate in the above requirements, then the Surveyor should endorse the deed, so the Auditor could transfer it to the Recorder.

During my emcumbency of Office, I found that the office of County Surveyor and the County Engineer's office should not be one and the same, but should be two seperate and distinct offices. The County Surveyor is elected by the people and he should be at all times willing to attend to the wants of the Public. He should receive a Salary, as most of the Couty Officials do at present and all fees received by him should go into the County Treasury. As the laws are at present, the official duties of County Surveyor are only in form. There is no Attorney who pays the least attention to the Books, which the Surveyor keeps as they are not official records.

I have found a great many instances where the Land Owners had more land than they had on the Tax Duplicate. I believe

all the Land in this County, (Brown) will average at least 4 per cent as a net gain in acreage for the County and would place at least $400,000.00 on the Tax Duplicate.

I as Chairman of this Committee, would suggest such legislation as would compel the County Commissioners of each County in this State, to employ a competent Surveyor to mark the Originai Corners of each of the Virginia Military Districts in their Counties, by sawed Free Stone monuments or cast iron posts, marked with the number of the Survey. All adjoining Land Owners who own land crossing such Survey Lines to make a seperate Description, when selling their land. All of these intermediate Corners to be marked by monuments of the same material, but of smaller size. If such a law was enacted, we as Surveyors would have some standing in Courts and could give each Land Owner his rights. In time to come all the disputed Lines would be corrected.

Report of Committee to Draft Resolutions on the Death of Mr. Edward P. Dickey.

We, your committee appointed to draft resolutions on the death of Edward P. Dickey, of Warren, Ohio, beg leave to submit the following report:

Whereas, God in his wisdom has removed from us our fellow member and co-laborer in the Ohio Society of Surveyors and Civil Engineers, Mr. Edward P. Dickey, causing an irreparable loss in our membership; therefore, be it

Resolved, That this Society extend to the bereaved family and friends its deepest sympathies in the loss of a true friend and worthy citizen; and

Resolved, That a copy of these resolutions be transmitted to the bereaved family.

HOMER C. WHITE,
I. L. STINEBAUGH,
W. H. BOUGHTON,
Committee.

Mr. Edward P. Dickey was born in the City of Warren, Ohio, May 26th 1847 and died at Pittston Pa., May 29th 1901. His youth was spent in his native city. After graduating from the Warren High School he took a course in Union College at Schenectady N. Y., graduating in 1870. He then accepted a position as Civil and Mining Engineer with the Pennsylvania Coal Company of Pittston Pa. which he held from 1870 to 1893.

He was appointed City Engineer of Warren in 1893, which office he filled till 1895 when he became general mine superintendent and engineer for the Butler Mine Company of Pittston, Pa. He remained with this company till 1897 when he again became City Engineer of Warren which position he held at the time of his death. He was united in marriage to Anna E. Ellithrop, of Edinburg N. Y., on April 23rd 1885 who survives him. The fruit of this union is one boy and one girl, both living. He was a member of the Presbyterian Church, and in politics was Republican. Mr. Dickey was one of the substantial and reliable men of the City and was doing much toward the improvement and elevation of the town of his nativity. His worth as a citizen, his ability, integrity, and conscientiousness as an official, his affability as an associate, and his never failing courtesy toward the public, were qualities recognized and appreciated by all who came to know him. He became a member of the Ohio Society of Surveyors and Civil Engineers in January 1898.

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Asher, J. H.	County Surveyor	London	Madison.
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Baldwin, Ward	Consulting Engineer	Cincinnati 64 Mitchell Building.	Hamilton.
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Barker, Frank M.	County Surveyor and City Engineer	Painesville	Lake.
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Bashore, T. H. B.	Deputy County Sur.	Paulding	Paulding.
Baum, J. L.	Civil Engineer and Surv.	Bournville	Ross.
Baumer, J. H.	Civil Engineer and Surv.	Cincinnati N. W. cor. Third and Main Sts.	Hamilton.
Bayne, J.	Assistant City Engineer, Pavements	Cleveland	Cuyahoga.
Beach, D. P.	Ass't Engineer Pa. Ry. Co.	Wellsville	Columbiana.
Beatty, J. G.	City Engineer	Columbiana	Columbiana.
Beatty, L. R.	Deputy County Surveyr.	Van Wert	Van Wert.
Beck, A. A.	Deputy County Surveyr.	Columbus	Franklin.
*Beckman, Louis	Manufacturer of Engineering Instruments	Toledo	Lucas.
Beebe, S. D.	Surveyor	Lakeside	Ottawa.
Beers, John	Civil Eng. and Prin. Engineering School	Greenville	Darke.
Beightler, Wm. P.	Surveyor	Marysville	Union.
Bement, Samuel	Civil Engineer and Sur.	Toledo 925 Willow Ave.	Lucas.
Bennett, C. M.	Chief Eng. C. & M. V. Ry.	Zanesville	Muskingum.
Berhout, E. N.	Civil Engineer and Sur.	Cleveland 153 Hanover St.	Cuyahoga.
Berry, E. L.	Co. Surv. and City Eng.	Ashland	Ashland.
Bill, H. W.	Civil Engineer and Sur.	Cleveland 87 Public Square.	Cuyahoga.
Billings, B. F.	Civil Engineer and Sur.	Blue Creek	Adams.
Binkerd, J. S.	Civil Engineer and Sur.	Dayton 327 Grafton Ave.	Montgomery.

Bird, S. Van	County Surveyor	Springfield	Clark.
Birnbaum, A. P.	Civil Engineer	Cincinnati 2735 Spring Grove Ave.	Hamilton.
Blackford, Rob. S.	Civil Engineer and Sur.	Columbus	Franklin.
Blair, F. J.	Civil Engineer and Sur.	Ashtabula	Ashtabula.
Blinn, R. S.	Architect and Civil Eng.	Coshocton	Coshocton.
Bloom, J. G.	Div. Eng. B. & O. R'y., Ohio Division	Chillicothe	Ross.
*Boalt, Eugene E.	Civil and Sanitary Eng.	Cleveland 45 Outhwaite Ave.	Cuyahoga.
Boarland, C. W.	Civil Engineer and Sur.	Pleasantville	Fairfield.
Boeh, Louis F.	Civil Engineer	Cincinnati 4135 Florida Ave.	Hamilton.
Boeh, W. H.	Chief Engr. Cincinnati Water Works	Cincinnati City Hall.	Hamilton.
Bolton, Elmer C.	City Engineer and Co. Surveyor	Findlay	Hancock.
*Bone, Frank A.	Jr. U. S. Engineer	Cincinnati	Hamilton.
Bonstedt, Frank.	With City Engineer	Akron	Summit.
Bordner Wm. H.	C. E. N. O. T. Co.	Akron	Summit.
Borst, C. H.	Ass't City Engineer	Akron	Summit.
Borton, D. C.	City Engineer	Massillon	Stark.
Bouscaren, G.	Civil Engineer Water Works Commission	Cincinnati City Hall.	Hamilton.
*Boughton, W. H.	Asst. Prof. Civ. Eng. Denison Univ. and Draftsman American Bridge Co., Prof. of Civ. Eng.-Eleçt, W. Va. Univ.	Granville	Licking.
Bouscaren, G.	Chief Eng. Bd. of Trus., Com'ners of Water-works	Cincinnati City Hall.	Hamilton.
Boustedt, Frank	Assistant City Engineer	Akron	Summit.
*Bowen, B. F.	Civil Engineer	Columbus 226 E. State St.	Franklin.
Bowen, F. C.	Deputy Co. Surveyor	Marion	Marion.
Bratt, Benj F.	Civil Engineer and Sur.	Portsmouth	Scioto.
Braun, Walter	Deputy Co. Surveyor	Columbus	Franklin.
Breen, J. E.	Ass't Eng. Bd. of P. S.	Cincinnati City Hall.	Hamilton.
Brentlinger, E.	Civil Engineer and Sur.	Dayton 1308 N. Main St.	Montgomery.
Brett, Bert	Civil Engineer and Sur.	Geneva	Ashtabula.
Bretz, A. E.	County Surveyor	Lancaster	Fairfield.

Brewer, I. C.	Civil Engineer and Sur.	Sandusky	Erie.
Breyman, Chas. H	Assistant City Engineer.	Toledo	Lucas.
Briggs, A. C.	Bridge Engr. Champion Bridge Works	Wilmington	Clinton.
Brinkerhoff, John.	Civil Engineer and Sur.	Wooster	Wayne.
Brommhall, Burt.	Surveyor	Spencers	Guernsey.
Brown, George	Draughtsman City Engineer's Office	Toledo	Lucas.
Brown, Hiram	Surveyor	Urbana	Champaign.
Brown, J. A.	City Engineer	Wilmington	Clinton.
Brown, Jay F.	Civil Engr. and Contr.	Cleveland 313 Electric Building.	Cuyahoga.
Brown, J. R. C.	Assistant City Engineer.	Gallipolis	Gallia.
Brown, W. F.	City Engineer	Toledo	Lucas.
Brumbaugh, W. D	City Engineer	Greenville	Darke.
Brunch, F. F.	Surveyor	Elyria	Lorain.
Bryan R. A.	Civil Engineer	Portsmouth	Scioto.
Buck, John T.	Civil Engineer and Sur.	Cardington	Morrow.
Buck, Thad. E.	County Surveyor	Mt. Gilead	Morrow.
Buell, C. W.	Civil Engineer and Sur.	Toledo 2052 N. 14th St.	Lucas.
Buell, James K.	Surveyor	John'nville	Trumbull.
*Burgess, Clar. H.	Civil Engr. and Contr.	Cleveland 29 Euclid Ave.	Cuyahoga.
Burke, M. D.	Civil Engineer	Cincinnati 404 Pike Building.	Hamilton.
Bushey, Chas.	Civil Engineer	Shelby	
Butler, J. H.	County Surveyor	Peebles	Adams.
Butts, W. H.	Ass't Eng. B. & O. R'y.	Cincinnati	Hamilton.
Buxton, C.	Chief Eng. T. & O. C. R'y	Toledo	Lucas.
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Cantrell, G. W.	Civil Engineer and Sur.	S. Brooklyn	Cuyahoga.
Carlisle, W. A.	Civil Engineer	Coshocton	Coshocton.
Carothers, D. D.	Civil Engr., Dept. M. of W., B. & O. R'y.	Cincinnati	Hamilton.
Carpenter, E. J.	Assistant U. S. Engineer	Cincinnati Government Bldg.	Hamilton.
Carson, Irvin	Assistant City Engineer.	Chillicothe	Ross.
Carter, Wm. J.	Ass't City Eng., Sewers.	Cleveland	Cuyahoga.
Cartwright, J. S.	City Engineer	Ottawa	Putnam.
Cassil, A.	City Engineer	Mt. Vernon	Knox.
Cassil, N. H.	Civil Engineer	Mt. Vernon	Knox.
*Cellarius, F. J.	Assistant City Engineer.	Dayton Room 8, City Building.	Montgomery.

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Chamberlin, J. R.	Civil Engr (at O. S. U.)	Tiffin	Seneca.
Chapin, L. E.	Civil Engineer	Canton	Stark.
Chase, R. D.	Civil Engineer and Sur.	Sandusky	Erie.
Chessel, Geo.	Civil Engineer and Sur.	Cleveland 423 Cuyahoga Bldg.	Cuyahoga.
Cobb, Fred C.	Ass't County Surveyor.	Akron	Summit.
Coffin, J. N.	Civil Engineer and Sur.	Cleveland 312 Perry Payne Building.	Cuyahoga.
Cogswell, F. F.	Civil Engineer and Sur.	Cleveland 1167 Pearl St.	Cuyahoga.
*Cole, Glen G.	County Surveyor	Holmesville	Holmes.
Cole, J.	County Surveyor	Ravenna	Portage.
Collins, R. G.	Civil Engineer	Zanesville	Muskingum.
Conklin, Frank	Civil Engineer and Sur.	P't Jefferson.	Shelby.
Consaul, Frank I.	Assistant City Engineer.	Toledo	Lucas.
Converse, H. J.	Civil Engineer and Sur.	Plain City.	Madison.
Conway, H. L.	Ass't Eng. Water Works	Cincinnati 2510 Hemlock St.	Hamilton.
Cook, J. D.	Civil Engineer and Sur.	Toledo 56 Law Building.	Lucas.
Cooke, Edward C.	Engineer Water Works.	Cleveland 822 Soc. for Sav. Building.	Cuyahoga.
Copeland, A. B.	Civil Engineer and Sur.	Cleveland 614 Cuyahoga Bldg.	Cuyahoga.
Core, I. P.	Transitman S. V. T. Co.	Frankfort	
Cormar, H. L.	Ass't Eng. B. & O. R'y.	Zanesville	Muskingum.
Cormar, T. C.	Civil Engineer and Sur.	Zanesville	Muskingum.
Corns, H. C.	Civil Engineer and Sur.	Ironton	Lawrence.
Correll, E. J.	Ass't Eng. B. & O. R'y., Ohio Division	Chillicothe	Ross.
Coryell, W. C.	Civil Engineer and Sur.	W. Union	Adams.
Counts, Charles	Ex-County Surveyor.	P't Jefferson.	Shelby.
Cowen, Clinton.	Surveyor	Cincinnati 540 Main St.	Hamilton.
Cox, James L.	Deputy County Surveyor	Brilliant	Jefferson.
Craig, Richard	Ex-County Surv; Civil and Mining Engineer	McArthur	Vinton.
*Craig, Samuel.	County Surv. and Engr.	Wapakoneta.	Auglaize.
Cramer, Chas.	Civil Engineer and Sur.	Shade	Athens.
Cronin, S. L.	County Surveyor	Woodsfield	Monroe
Cronley, J. C.	County Surveyor and Civil Engineer	Lima	Allen.
Cully, Fred S.	County Surveyor	Newark	Licking.
Cully George.	Civil Engineer and Sur.	Cleveland 33 Blackstone Bldg.	Cuyahoga.
Curfman, Samuel.	City Engineer	Steubenville	Jefferson.
Curtis, L. G.	Dept. M. of W., B. & O. R'y.	Zanesville	Muskingum.

Danenhower, C. N	Civil Engineer	Cincinnati	Hamilton.
		1215 Jackson St.	
Danford, B.	County Surveyor	Whigville	Noble.
Darst, B. F.	Civil Engineer and Sur.	Shoups Sta.	Greene.
Davis, C. B.	Assi't City Engineer	Cambridge	Guernsey.
Davis, C. R.	Res. Eng. S. V. T. Co.	Carroll	
Davis, Chas S.	Civil Engineer and Sur.	Toledo	Lucas.
*Davis, Jno B.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		242 The Arcade.	
Davis, J. C.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
Davis, J. D.	Ex-County Surveyor	Chester Hill	Morgan.
Davis, M. L.	Civil Engineer	Lisbon	Columbiana.
Davis, Solon	Civil Engineer and Sur.	Weston	Wood.
Davis, W. L.	Civil Engineer and Sur.	Ironton	Lawrence.
*Davisson, F. M.	Civil Engineer and Sur.	W. Manchester	Preble.
Dawley, W. M.	Ass't Eng. B. & O. R'y.	Cincinnati	Hamilton.
*Dewitt, Chas. E.	Civil Engr. and County Surveyor	Pt. Clinton	Ottawa.
*DeMotte, R. K.	County Surveyor and Civil Engineer	Eaton	Preble.
Denison, L. B.	Civil Engineer and Sur.	Delaware	Delaware.
Dennick, Ed.	Draftsman, Mt. Vernon Bridge Co.	Mt. Vernon	Knox.
Dercum, Otto	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		362 Sibley St.	
Dermott, W. J.	Res. Engr. S. V. T. Co.	Canal Winches.	
Derrickson, G. M.	Civil Engineer and Sur.	Akron	Summit.
Deutsch, John	Surveyor	Clinton	Summit.
Devenish, R. J.	Ass't Eng. Bd. of Trus., Com'ners of Water-works	California	
Devereux, H.	Res. Engr. B. & O. R'y.	Cincinnati	Hamilton.
Devore, L. N.	Engineer Bellefontaine Bridge Co.	Bellefontaine	Logan.
Dick, H. B.	Chief Eng. P. & L. K. R'y.	Zanesville	Muskingum.
Dickens, E.	Civil Engineer and Sur.	Pedro	Lawrence.
Dickinson, L. A.	Civil Engineer and Sur.	Fremont	Sandusky.
Diemar, C. R.	County Surveyor	Ironton	Lawrence.
Dike, J. S.	Deputy Co. Surveyor	Delaware	Delaware
*Dillon, L. A.	County Surveyor	Hamilton	Butler.
Dimock, E. W.	Civil Engineer and Sur.	Dupont	Putnam.
Dixon, J. R.	Civil Engineer and Sur.	Orwell	Ashtabula.
Doak, A. S.	County Surveyor	Winchester	Adams.
Doane, L. W.	Civil Engineer and Sur.	Zanesville	Muskingum.
Donham, David	Civil Engineer and Sur.	Lindale	Clermont.
Donnelly, J. F.	Dep. County Surveyor	Montpelier	Williams.
Doty, Frauk	City Engineer	Middletown	Butler.

Doty, George	Civil Engineer and Sur.	Edon	Williams.
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Dowson, W. C.	Civil Engineer	Cincinnati	Hamilton.
		2617 Cleinview Ave.	
Dumm, R. R.	Ex-County Surveyor	Wharton	Wyandot.
Dunn, J. J.	Civil Engineer	Columbus	Franklin.
Dunn, Wm.	County Surveyor	Zanesville	Muskingum.
Dwyer, Geo. H.	Ass't City Engineer	Marion	Marion.
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		1309 Cedar Ave.	
Egerton, J. T.	County Surveyor	Ironton	Lawrence.
Eldridge, Wm.	Surveyor	Bartlett	Washington.
Eldridge, J. J.	Surveyor	Bartlett	Washington.
Ellis, Jeremiah	(From Adams Co., O.	Concord, Ky.	
Ells, Wm. B.	Civil Engineer	Mt. Gilead	Morrow.
English, D. H.	Surveyor	Defiance	Defiance.
Engle, Robert L.	Civil Engineer and Sur.	Cincinnati	Hamilton.
		1530 Westminster Ave.	
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Estep, E. J.	Ass't City Eng., Surveys	Cleveland	Cuyahoga.
*Evers, Wm. H.	County Surveyor	Cleveland	Cuyahoga.
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Farbell, J. D.	Civil Engineer and Sur.	Bedford	Cuyahoga.
Fauver, Lester	County Surveyor	Elyria	Lorain.
Fawcett, Joseph	Civil Engineer	Carrollton	Carroll.
Fawcett, John	Civil Engineer	Kilgore	Carroll.
Fawcett, Oscar	Surveyor	Walnut Grove	Logan.
Felter, Geo. W.	Civil Engineer and Sur.	Williamsburg	Clermont.
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Fishbaugh, A. W.	Co. Surv. and City Eng.	Celina	Mercer.
*Fischer, E. H.	Civil Engineer and Sur.	Lockbourne	Franklin.
Fisher, A. M.	Civil Engineer and Sur.	Coshocton	Coshocton.
Fisher, J. E.	Civil Engineer and Sur.	Bowling Green	Wood.
Fitzgerald, J.	Civil Engineer and Sur.	Conneaut	Ashtabula.

Fitzpatrick, And.	Civil Engineer	Fayetteville	Brown.
Flickinger, H. V.	County Surveyor	Bucyrus	Crawford.
Force, John P.	Civil Engineer and Sur.	Cleveland 504 Soc. for Sav. Bldg.	Cuyahoga.
Force, John P.	Ass't Eng. Dept. Pub. Improvement	Columbus	Franklin.
Ford Collin, Jr.	Civil Engineer	Cincinnati 413 Vine St.	Hamilton.
Fout, Lafayette	Surveyor	Portsmouth	Scioto.
Flynn, B. H.	Eng. Ohio State Bd. of Health	Columbus	Franklin.
Fox, H. S.	Civil Engineer and Sur.	Brookville	Montgomery.
Fox, Al	Civil Engineer and Sur.	Brookville	Montgomery.
Fox, W. S.	Surveyor	Shortcreek	Harrison.
Fox & Goodspeed	Mining Engineers	Nelsonville	Athens.
Flanigan, C. E.	Civil Engineer and Sur.	Steubenville	Jefferson.
Frank, Ernest	Surveyor	Oak Harbor	Ottawa.
Franklin, Byron	County Surveyor	Wilmington	Clinton.
Frazier, T. J.	Ass't Eng. B. & O. R. R.	Zanesville	Muskingum.
French, Morris	City Engineer	Salem	Columbiana.
Fullerton, A. L.	Architect and Civil Eng.	Chillicothe	Ross.
Galvin, Archie J.	Ass't City Engineer	Cleveland 128 Franklin Ave.	Cuyahoga.
Gamble, R. H.	City Engineer	Lima	Allen.
*Ganyard, L. B.	County Surveyor	Medina	Medina.
Garber, John M.	Draughtsman Mt. Vernon Bridge Co.	Mt. Vernon	Knox.
Gardner, A. E.	Civil Engineer and Sur.	Rutland	Meigs.
Garrett, Geo. M.	Civil Engineer and Sur.	Cleveland 831 Cuyahoga Bldg.	Cuyahoga.
*Gates, H. M.	Civil Engineer	Columbus 23½ N. High St.	Franklin.
Gates, E. Frank	City Engineer	Marietta	Washington.
Gates, C. L.	Eng. Toledo Bridge Co.	Toledo	Lucas.
Gault, Homer J.	Civil Engineer and Sur.	Cleveland 17 Lake Ave.	Cuyahoga.
Geddes, George	Surveyor	Hoskinsville	Noble.
Geddes, J. K.	Chief Eng. B. Z. & C. R. R.	Zanesville	Muskingum.
Gehres, J. A.	County Surveyor	Akron	Summit.
Gellitle, W. E.	Civil Engineer and Sur.	Clyde	Sandusky.
George, Jno. A.	City Engineer	E. Liverpool	Columbiana.
Gerrish, Wm. B.	City Engineer	Oberlin	Lorain.
Gessner, G. A.	Ass't City Engineer	Toledo	Lucas.
Giessen, Chas. H.	Civil Engineer and Sur.	Cleveland 20 Blackstone Bldg.	Cuyahoga.

Gilbert, ——..... Surveyor ....Venice, Ross P. O....Butler.
Gillen, Edward...Surveyor...............Akron ....Summit.
*Gillett, M. M....Civil Engineer ....Newark ......Licking.
*Gilpatrick, J. L..Prof. Mathematics Den-
nison University .....Granville .....Licking.
Ginn, W. A.......County Surveyor ....Bellefontaine.. Logan.
Glasgow, W. R...Civil Engineer and Sur. Shiloh ....Richland.
Glathart, H. A...Civil Engineer and Sur. Findlay ....Hancock.
Goldfogle, David. Civil Engineer ....Cincinnati ....Hamilton
Dennison Hotel.
Good, Chas. W. B. Assistant Engineer .....Ashland ......Ashland.
Good, Emery H..Dep. County Surveyor..Tiffin ....Seneca.
Goodell, R. S.....Prin. Ass't Engineer Mt.
Vernon Birdge Co...Mt. Vernon....Knox.
Goodspeed & Fox Mining Engineers ......Nelsonville ...Athens.
*Gordon, C. M...Eng. R. G. H. & C. R. R.
Co. ....Georgetown ...Brown.
Gordon, H. J.....Surveyor ....Oak Harbor ..Ottawa.
Graf, Edwin.....Ass't City Engineer.....Canton ....Stark.
Graham, E. E.....Draftsman Morgan Eng.
Co. ....Alliance. Stark.
Graham, Alva ...Surveyor ....Marysville ....Union.
Greek, Jacob .....City Engineer ...Upper Sandusky .....Wyandot.
Griffin, O. U.....Civil Engineer and Sur. Fayette ....Fulton.
(P. O. Morenci, Mich.)
Green, B. J.......County Surveyor ....Cadiz ....Harrison.
Griggs, Julian ...Chief Eng. Dep. Public
Improvements ....Columbus .....Franklin.
Grim, John C....Civil Engineer and Sur. Bryan ....Williams.
*Groves, John W. Eng. Boomer Coal and
Coke Co. ....Boomer, W. Va.
*Gyer, George R..Civil Engineer and Sur. Alliance ......Stark.

Hallinan, M. J....With City Engineer....Akron ....Summit.
*Hanlon, John A. City Eng....17 The Eu-
clid ....Cleveland .....Cuyahoga.
*Hanlon, Wm. B. Ass't Eng. B. & O. R'y..Cleveland .....Cuyahoga.
Harlan, B. H.....Civil Engineer and Sur.,
Lima Steel Co. ......Lima. Allen.
*Harper, J. M....Civil Engineer ....Cincinnati ....Hamilton.
1546 Baymiller St.
Harrison, B. W...County Surveyor ......Cincinnati ....Hamilton.
Court House.
Harvey, E. E.....City Engineer ....London ....Madison.
Harvey, John ....Ass't County Engineer..Hamilton .....Butler.
*Harvey, L. B....Civil Engineer and Sur. Marysville ....Union.
*Haseltine, E. D. Civil Engineer and Sur. Youngstown ..Mahoning.
Haseltine, R. M..Civil Engineer and Sur. Youngstown ..Mahoning.

Hatcher, John D.	Civil Engineer and Sur.	Forest Dale	Lawrence.
Hatcher, W. B. G.	Civil Engineer and Sur., Coal Works	Sheridan	Lawrence.
Hayward, G. E.	County Surveyor	N Philadelphia	Tuscarawas.
Hecker, R.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		412 Electric Bldg.	
Henderson, J. C.	Surveyor	Archer	Harrison.
Henretta, C. M.	Mining Engineer	Cambridge	Guernsey.
Herndon, John C.	Surveyor	Akron	Summit.
Herndon, Z. T.	Civil Engineer	Akron	Summit.
Hewitt, B. F.	Civil Engineer and Sur.	Conneaut	Ashtabula.
Heyl Brothers	Surveyors	Cincinnati	Hamilton.
		N. E. cor Hopkins and Linn.	
Hibbard, S. H.	County Surveyor	Athens	Athens.
Hibbs, Wm.	Mining Engineer	Scio	Harrison.
Hill, George H.	Civil Engineer and Sur.	Milford	Clermont.
Hill, John W.	Civil Engineer	Cincinnati	Hamilton.
		35 Glenn Bldg.	
Hiller, John A.	Ass't Eng. Bd. of Trus., Comnrs. of Water-works	Cincinnati	Hamilton.
		2545 Eastern Ave.	
Hoadley, J. S.	County Surveyor	Bryan	Williams.
Hobby, Arthur S.	Civil Engineer	Cincinnati	Hamilton.
		33 Wiggin's Block.	
Hochenedel, C. A.	Civil Engineer and Sur.	Fremont	Sandusky.
Hoffman, C.	Surveyor	Doylestown	Wayne.
Hofman, Joseph	Civil Engineer and Sur.	Toledo	Lucas.
		3118 Cherry St.	
Hoge, Ernest	Surveyor	Guernsey	Guernsey.
Hoge, O. M.	City Engineer	Cambridge	Guernsey.
Holl, J. H.	Civil Engineer	Canton	Stark.
Hollister, G. G.	Surveyor	Dunham	Washington.
Holton, H. S.	Ass't Eng. Dept. of Pub. Improvements	Columbus	Franklin.
Holtz, L. E.	Civil Engineer and Sur.	Ottawa	Putnam.
Hood, Robt.	Civil Engineer and Sur.	Cedarville	Green.
Hoover, J. S.	County Surveyor and Civil Engineer	Canton	Stark.
Hosbrook, D. S.	Surveyor	Cincinnati	Hamilton.
		65 Pickering Bldg.	
Hosbrook, J. Asa	Surveyor	Cincinnati	Hamilton.
		429 Pike Bldg.	
Houglin, G. M.	Dep. County Surveyor	Paulding	Paulding.
House, J. E.	County Surveyor and City Engineer	Sidney	Shelby.

Howe, Chas. S.	Prof. Math. and Astron., Case School of Applied Sciences	Cleveland	Cuyahoga.
Howison, Earl	Civil Engineer and Sur.	Warrensburg	Delaware.
Hoyt, Geo. M.	Surveyor	Perry	Lake.
Hoyt, M. B.	Ex-County Surveyor	Delta	Fulton.
Huddle, J. D.	County Surveyor	Ottawa	Putnam.
Hudson, D. P.	Dep. County Surveyor and Civil Engineer	Napoleon	Henry.
Hudson, W. O.	Civil Engineer and Sur.	Napoleon	Henry.
Huge, E. W.	Surveyor	Cincinnati S. E. cor. Ninth and Vine Sts.	Hamilton.
Hughes, Henry	County Surveyor and City Engineer	Fremont	Sandusky.
Hughes, ———	Ass't City Engineer	Niles	Trumbull.
Hunt, H. E.	County Surveyor	Jackson	Jackson.
Huntington, E.	Civil Engineer and Sur.	Painesville	Lake.
Husey, Geo. D.	Civil Engineer	Youngstown	Mahoning.
*Huston, Sam.	County Surveyor	Steubenville	Jefferson.
Hutchinson, C. E.	Dep. County Surveyor	Kenton	Hardin.
Hutson, A. V.	Civil Engineer and Sur.	Bentonville	Adams.
Hyde, A. Lincoln	Civil Engineer and Sur.	Cleveland New England Bldg.	Cuyahoga.
Jackson, E. S. Jr.	Civil Engineer	Elyria	Lorain.
Jacobs, Bert	Dep. County Surveyor	Washington C. H.	Fayette.
Jacobs, D. R.	County Surveyor	Washington C. H.	Fayette.
Jandus, W.	Civil Engineer and Sur.	Cleveland 861 Rose Bldg.	Cuyahoga.
Jaques, Ira	Eng. M. of W., C. A. & C. R. R.	Akron	Summit.
*Jenkins, W.H.W.	Civil Engineer and Sur.	Portsmouth 1329 Grandview Av.	Scioto.
Jenkins, W. H.	Transitman P. C. C. & St. L. Ry.	Columbus	Franklin.
Jewett, D. S.	Civil Engineer	Cincinnati 2527 Gilbert Ave.	Hamilton.
Jewett, Wm. C.	Res. Eng. Bd. of Trus., Comnrs of Waterworks	Cincinnati 541 Ridgewa yAve.	Hamilton.
Johnson, A.	Surveyor	Paint Valley	Holmes.
Johnson, S. A.	County Surveyor	Racine	Meigs.
Johnson, W. H.	Civil Engineer and Sur.	Barberton	Summit.
Johnson, W. J.	County Surveyor	Paulding	Paulding.
Johnston, John F.	Civil Engineer	Cuyahoga Falls	Summit.
Johnston, Wm. A.	Civil Engineer	Akron	Summit.

*Jones, A. W.....County Sur. and Chief Eng. & Gen. Mngr. Scioto Valley Traction Co. ....Chillicothe ...Ross.
Jones, Lafayette..County Surv. and Eng..Portsmouth ..Scioto.
Jones, Shannon...Civil Engineer and Sur.Jerusalem ....Monroe.
Jonte, P. N.......Surveyor ....Cincinnati ....Hamilton.
Room 3, No. 134 E. Court St.
Jopling, R. F.....Mining Engineer ....Cleveland ....Cuyahoga.
416 Cuyahoga Bldg.
Judson, A. W....County Surveyor ....Sandusky .....Erie.
*Judson. C. A....Civil Engineer ....Sandusky .....Erie.

Kaney, T. G......Civil Engineer and Sur.Toledo ....Lucas.
335 Superior St.
Kearfott. Wm. D.Man. for H. R. Worthington ....Cleveland ....Cuyahoga.
Keenan, Emmet...Surveyor ....Batesville ....Noble.
Keith. John......Surveyor ....Spencerville ..Allen.
Kelly, J. C........Civil Engineer ....E. Liverpool..Columbiana.
*Kemmler, E. A..Ass't City Engineer ....Columbus ....Franklin.
Kemper, W. R....City Engineer ....Lebanon .....Warren.
Kennedy, F. M...Civil Engineer and Sur. Washington C. H., Fayette.
Kennedy, J. C.....County Surveyor and City Engineer ....Marysville ....Union.
Kennon, D. C....Civil Engineer ....Barnesville ...Guernsey.
Keuthan, Ferd....City Engineer ....St. Marys ....Auglaize.
Kimble, W. P....Eng. M. of W., Cincin. Div Erie Ry. ....Crawford.
King. S...........Ass't City Engineer....Youngstown ..Mahoning.
Kingsley, M. W..Civil, Hydraulic & Consulting Engineer ....Cleveland ....Cuyahoga.
Kinnear, Josiah ..Civil Engineer ....Columbus ....Franklin.
652 E. Long St.
Kirk, Eugene ....Civil Engineer and Sur.Youngstown ..Mahoning.
Kittredge, Geo. W Chief Eng. C. C. C. & St. L. Ry. ....Cincinnati ....Hamilton.
Kline, Chas. ......Civil Engineer and Sur.Dayton ....Montgomery.
*Kline, Robt. E...Civil Engineer and Sur. Dayton ....Montgomery.
Callahan Bank Bldg.
Knepp, Henry ...Surveyor ....Creston ......Wayne.
Knorr, H. E......Ass't County Engineer..Cincinnati ....Hamilton.
Court House.
Knouff, O M.....Civil Engineer ....Caldwell ..... Noble.
Koehler, Nicholas Dep. County Surveyor ..Columbus .... Franklin.
Kolbe, Henry.....Civil Engineer and Sur.Napoleon .....Henry.
Krause, Frank B.Civil Engineer and Sur.Cleveland .....Cuyahoga.
238 Society for Savings Bldg.

Krause, Frank L. Civil Engineer and Sur. Cleveland ....Cuyahoga.
238 Society for Savings Bldg.
Kritzinger, H. B.. Surveyor .... Paulding ..... Paulding.
Krug, F. S....... County Engineer .... Cincinnati .... Hamilton.
Court House.
Kurz, Wm. A.... Civil Engineer and Sur. Cleveland ....Cuyahoga.
504 American Trust Bldg.

Laird, Ed........ Ass't City Engineer .... Tiffin .... Seneca.
Columbia St.
Laird, Jacob...... City Engineer .... Mansfield .... Richland.
Lakeman, W..... Civil Engineer .... Cincinnati .... Hamilton.
4310 Beech Hill Ave.
Lander, Frank R. County Draughtsman ... Cleveland ....Cuyahoga.
321 Marcy Ave.
Lane, J. D....... County Surveyor and
City Engineer .... Carrollton .... Carroll.
Large, J. H...... Civil Engineer .... Whigsville ... Noble.
*Laylin, John .... Co. Sur. and City Eng.. Norwalk ..... Huron.
Layman, E. F.... Civil Engineer and Sur. Cincinnati .... Hamilton.
32 E. Third St.
Lee, R. H......... Civil Engineer and Sur. Harlemsprings Carroll.
Leete, Fred G.... City Engineer .... Ironton .... Lawrence.
Legg, E. E........ Civil Engineer .... Columbus ..... Franklin.
251 N. Garfield Ave.
Leonard, M. F... County Surveyor and
City Engineer .... Gallipolis ..... Gallia.
Lesher, Geo. W.. Civil Engineer and Sur. Fremont ...... Sandusky.
Lewis, Chas. F... Bridge Engineer .... Cleveland ..... Cuyahoga.
307 Cuyahoga Bldg.
Lewis, C. McK... Bridge and Signal Eng.
B. & O. Ry.......... Cincinnati .... Hamilton.
*Lewis, Harry J.. Civil Eng., genl practice Pittsburg, Pa.
Times Bldg.
*Lillie, F. M...... City Engineer .... Youngstown .. Mahoning.
Lilly, G. W...... Ass't Eng. Dept. of Pub.
Improvements .... Columbus ..... Franklin.
Lilly, J. A........ Civil Engineer .... Cincinnati .... Hamilton.
Linton, W. H.... City Engineer .... Ravenna ...... Portage.
Locke, Jos. M.... Civil Engineer .... Cincinnati .... Hamilton.
40 E. Third St.
Long, M. A....... Ass't Eng. B. & O. Ry... Cincinnati .... Hamilton.
*Loofburrough,
E. C........... Civil Engineer .... Lorain .... Lorain.
Loomis, A. B..... Civil Engineer and Sur. Toledo .... Lucas.
The Monticello.
Lorce, W. C..... Acting Supt. P. C. C. C.
& St. L. Ry. Co...... Columbus ..... Franklin.
Union Station.

Lowry, R. E.	Civil Engineer and Sur.	Eaton	Preble.
Ludwig, H. L.	Ass't City Engineer	Portsmouth	Scioto.
Lutz, Martin	Surveyor and Engineer	Celina	Mercer.
Machen, C. H.	Ass't Eng B. & O. Ry.	Cincinnati	Hamilton.
Mackey, Charles	Civil Engineer and Sur.	Youngstown	Mahoning.
Mackey, James	Civil Engineer and Sur.	Youngstown	Mahoning.
Maclennan, J. D.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		527 Garfield Bldg.	
Madigan, John	Surveyor	Akron	Summit.
Maetzel, Henry	County Surveyor	Columbus	Franklin.
Maidlow, J. T.	Dep. County Surveyor	Ottawa	Putnam.
Malhouhan, M.	Ass't Eng. B. & O. Ry.	Cincinnati	Hamilton.
Malick, I. H.	County Surveyor	Van Wert	Van Wert.
Mann, H. E.	City Engineer	Ashtabula	Ashtabula.
Mann, N. L.	Surveyor	West Mansfield	Logan.
Marble, R. R.	Civil Engineer	Columbus	Franklin.
Mark, Chas. E.	Chief Eng. T. & O. C. Ry. Co.	Columbus	Franklin.
Markley, Philip	Ex-County Surveyor	Wooster	Wayne.
Marsh, Dillon	Mining Engineer	Byesville	Guernsey.
Marston, J. B.	Civil Engineer	Toledo	Lucas.
		312 Superior St.	
Martin, J. H.	Dep. County Surveyor	Greenville	Darke.
Martin, C. V.	Ass't City Engineer	Zanesville	Muskingum.
Mason, W. P.	Civil Engineer	Marietta	Washington.
Mathewson, L. W	Civil Engineer	Cincinnati	Hamilton.
		4222 Chambers St.	
Mattoon, J. A.	Civil Engineer and Sur.	Pulaski	Williams.
Maynard, M. S.	Surveyor	Chardon	Geauga.
McCarren, Frank	Civil Engineer	Cincinnati	Hamilton.
		2617 Cleinview Ave.	
McConnell, Silas	Eng. P. C. C. & St. L. Ry.	Steubenville	Jefferson.
McCormick, W.M.	Civil Engineer and Sur.	Seaman	Adams.
McCrory, John	Surveyor	Fredericktown	Knox.
McCullough, J. C.	Civil Engineer	Lima	Allen.
McDaniel, J. W.	Civil Engineer and Sur.	Rockwood	Lawrence.
McDargh, Harry	Ass't Civil Engineer	Dayton	Montgomery.
*McDonald, H.W	Sanitary Engineer	Galion	Crawford.
McFarland, C. R.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		907 New England Bldg.	
McKahan, James	Surveyor	Sugartree	Guernsey.
*McKay, G. A.	County Surveyor	Xenia	Greene.
McKinley, Robert	Civil Engineer and Sur.	Youngstown	Mahoning.
McManis, J. O.	Civil Engineer and Sur.	West Union	Adams.
Meeds, C. H.	Ass't U. S. Engineer	Cincinnati	Hamilton.
		518 Walnut St.	

Mendenhall, E. S.	Civil Engineer and Sur.	Delaware	Delaware.
Merry, L. D.	Surveyor	Caldwell	Noble.
Mesnard, L. B.	Civil Eng. and Contr.	Norwalk	Huron.
Michel, Wm.	Eng. M. of W., Hocking Valley Ry. Co.	Columbus	Franklin.
Miller, Chas.	Civil Engineer and Sur.	Bantam	Clermont.
Miller, Clarence	Dep. County Surveyor	Bellefontaine	Logan.
Miller, Clifford N	Ass't Eng. Bd. of Trus., Comnr of Waterworks, City Hall	Cincinnati City Hall.	Hamilton.
Miller, E. M.	Dep. County Surveyor	Greenville	Darke.
Miller, J. E.	Engineer Bellefontaine Bridge Co.	Bellefontaine	Logan.
Miller, John W.	Civil Engineer and Sur.	Sandusky	Erie.
Mishler, Jacob	Surveyor	Magadore	Summit.
Mishler, Menno	Surveyor	Magadore	Summit.
Mitchell, Frank S.	Civil Engineer	Bellefontaine	Logan.
Moeser, Edmund.	U. S. Eng. in charge of Muskingum River		Muskingum.
Monfort, P. O.	County Surveyor and Civil Engineer	Lebanon	Warren.
Montgomery, G. M	County Surveyor	Youngstown	Mahoning.
Moore, H. C.	Civil Engineer and Sur.	Bellefontaine	Logan.
Moore, S. F.	Civil Engineer	Coshocton	Coshocton.
Moore, Saml M.	County Surveyor and Civil Engineer	Coshocton	Coshocton
Morgan, Arthur L	Civil Engineer	Zanesville	Muskingum.
Morgan, M. E.	Dep. County Surveyor	Urbana	Champaign.
Morris, C. T.	Draughtsman Youngstown Bridge Co.	Youngstown.	Mahoning.
Morris, Frank E.	Ass't Eng. Bd. of Public Service. City Hall	Cincinnati 2846 Harrison Ave.	Hamilton.
Morrow, Oliver	City Engineer	Paulding	Paulding.
Morse, Christ	Civil Engineer and Sur.	London	Madison.
Mote, Duke	Civil Engineer	Greenville	Darke.
Mowry, Andrew S	Surveyor	Marysville	Union.
Mowery, H. W.	County Surveyor	Wooster	Wayne.
*Munn, M. A.	Div. Eng. Cleveland & Eastern Ry.	Cleveland	Cuyahoga.
Munson, H. N.	Surveyor	Mentor	Lake.
Murray, Paul R.	Civil Engineer	Malta	Morgan.
Myers, W. W.	City Engineer	Kenton	Hardin.
Neff, Nettleton	Acting Eng. M. of W., P. C. C. & St. L. Ry.	Columbus Union Station.	Franklin.

*Newberry, S. B.	Man. and Chemist Sandusky Portland Cement Co.	Sandusky	Erie.
*Nicholson, G. B.	Chief Eng. C. N. O. & T. P. Ry.	Cincinnati	Hamilton.
*Niederheiser, F.L	Surveyor and Civil Eng.	Ashland	Ashland.
Noble, P. B.	Ass't Eng. Dept. Public Improvements	Columbus	Franklin.
Noyes, H.	County Surveyor	Marion	Marion.
Oakley, F. T.	Civil Engineer and Sur.	Toledo The Spitzer.	Lucas.
Oberbeck, Aaron	Civil Engineer and Sur.	Ottawa	Putnam.
Ogden, J. P.	Ass't City Eng., Pavements	Cleveland	Cuyahoga.
Okey, John	Civil Engineer and Sur.	Stafford	Monroe.
Oliphant, John C.	First Ass't City Eng.	Toledo	Lucas.
Osborn, Frank C.	The Osborn Eng. Co.	Cleveland Osborn Bldg.	Cuyahoga.
Overman, H. W.	Civil Engineer and Sur.	Waverly	Pike.
Page, John	Sur. and Civil Engineer. Ass't Supt. Buckeye Pipe Line Co.	Lima	Allen.
Pardu, G. D.	Ass't City Eng., Bridges	Cleveland	Cuyahoga.
Parshall, S. W.	Civil Engineer and Sur.	Akron	Summit.
Patten, C. O.	Surveyor	Locust Ridge	Brown.
Paul, E. W.	Civil Engineer and Sur.	Akron	Summit.
Paul, Hosea	Civil Engineer and Sur.	Akron	Summit.
*Paul, Robert S.	Civil Engineer and Sur.	Akron	Summit.
Paul, T. Dwight	Chief Eng. A. & B. R. R.	Akron	Summit.
Payne, Earl H.	Civil Engineer and Sur.	Cleveland 96 Claasen St.	Cuyahoga.
Payne, John W.	City Engineer	Akron	Summit.
Payne, N. W.	Surveyor	Port Clinton	Ottawa.
Pease, F. A.	Dep. County Surveyor	Cleveland Lakeview Ave.	Cuyahoga.
Peck, Thos. K.	Civil Engineer and Sur.	Hudson	Summit.
Pedlow, E. B.	Supt. C. & H., C. & I. Co.	New Str'tsville	Perry.
Perkins, Chas. E.	Chief Eng. State Bd. of Public Works	Columbus	Franklin.
Perry, L. G.	Surveyor	Miamisburg	Montgomery.
*Peters, Chas. J.	County Surveyor and City Engineer	Tiffin	Seneca.
Petri, P.	Ass't Eng. B. & O. Ry.	Cincinnati	Hamilton.
Petry, Alfred	Civil Engineer	Cincinnati Water Wks. Commrs. Office.	Hamilton.

Phelps, Edwin L..	Dep. County Surveyor and Civil Engineer...	Chardon	Geauga.
Phelps, E. S. F...	County Surveyor and Civil Engineer	Chardon	Geauga.
Phifer, Edwin ...	County Surv. and Eng..	Findlay	Hancock.
Philson, L. W....	Dep. County Surveyor..	Racine	Meigs.
Phinney, John B..	Civil Engineer and Sur.	Sandusky	Erie.
Picard, F. J......	Civil Engineer	Columbus	Franklin.
Pierce, George M.	Civil Engineer and Sur.	Cleveland ..... 315 Amer. Trust Bldg.	Cuyahoga.
Pierson, I. K....	Civil Engineer and Sur.	Cleveland ..... 416 Cuyahoga Bldg.	Cuyahoga.
Pillars, James....	Ass't City Engineer....	Lima	Allen.
Pitser, A. R......	Surveyor	Newark	Licking.
Plumer, J. A.....	Civil Engineer and Sur.	Marietta	Washington.
Polk, W. C.......	Civil Engineer C. U. Telephone Co.	Columbus	Franklin.
Porter, Warren S.	Civil Engineer and Sur.	Cleveland ..... Lake Front Ave.	Cuyahoga.
Potts, J. C........	County Surveyor	Mansfield	Richland.
Pratt, C. W......	Civil & Landscape Eng.	Cleveland ..... 712 Hickox Bldg.	Cuyahoga.
Pratt, W. H......	Mngr. Illinois Steel Co.	Chicago, Ill. 50 Wabash Ave.	
Price, J. W......	Engineer B. & O. Ry....	Attica	Seneca.
Punshon, Thos. B	Civil Engineer	Cincinnati ..... S. W. cor 5th and Race Sts.	Hamilton.
Purdue, Thos. K.	Civil Engineer and Sur.	Washington C. H.,	Fayette.
Putnam, M.......	Civil Engineer and Sur.	Rising Sun ...	Sandusky.
Quilter, Thos. M.	Civil Engineer and Sur.	Fremont	Sandusky.
Rabbe, J. A.......	Civil Engineer	Cincinnati .... 404 Pike Bldg.	Hamilton.
Randabugh, Jno...	Civil Engineer	Celina	Mercer.
Rawson, J. L.....	Civil Engineer and Sur.	Fremont	Sandusky.
Ray, W. M.......	Ass't Eng. B. & O. Ry..	Cleveland	Cuyahoga.
Raymond, C. A...	Bridge Draughtsman....	Wauseon	Fulton.
Read, H. M......	City Engineer	Chillicothe	Ross.
Read, R. L.......	Civil Engineer	Cincinnati .... 32 E. Second St.	Hamilton.
Reamer, C. L. V..	Surveyor	Coshocton.	Coshocton.
Reed, W. C......	Civil Engineer	Millersburg ...	Holmes.
Reel, H M.......	Ass't City Engineer.....	Youngstown ..	Mahoning.
Reichenbach, Fred	Civil Engineer	Canton	Stark.

Reid, A. L.	Dep. County Surveyor and Civil Engineer	Eaton	Preble.
Reighard, Frank H	County Surveyor	Wauseon	Fulton.
Reigle, J. W. S.	City Engineer	Findlay	Hancock.
Reigler, Louis	Civil Engineer	Canton	Stark.
Renick, Seymore	Civil Engineer and Sur.	London	Madison.
Reno, James M.	Civil Engineer	Youngstown	Mahoning.
Reynolds, Crayton	Civil Engineer and Sur.	Peebles	Adams.
Rice, Walter P.	With W. P. Rice Eng. Co.	Cleveland.	Cuyahoga.
		732 Soc. for Savings Bldg.	
Richards, James	Mining Engineer	Glouster	Athens.
Richie, Charles	Surveyor	Summerfield	Noble.
Richie, Didamus	Mining Engineer	Jackson	Jackson.
Richie, James	City Engineer	Cleveland	Cuyahoga.
		625 Hickox Bldg.	
Riddell, Levi	Civil Engineer and Sur.	Xenia	Green.
*Riegler, L. J.	Civil Engineer P. R. R.	Pittsburg, Pa.	
Rifenberick, R. B.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		1521-1522 Williamson Bldg.	
Riggs, H. E.	Civil Engineer and Sur.	Toledo	Lucas.
		613 The Nasby.	
Riggs, M. J.	Chief Engineer Toledo Bridge Co.	Toledo	Lucas.
Rimer, James W.	City Engineer	Van Wert	Van Wert.
Riley, Geo. W.	Civil Engineer and Sur.	Miamisburg	Montgomery.
Rist, W. J.	Ass't Eng. M. of W., Cin. Div. Erie Ry.		Crawford.
Ritchie & Ruple	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		412 Cham. of Com. Bldg.	
Roberts, F. C.	Surveyor	W. Elkton	Preble.
Robinson, H. H.	Dep. County Surveyor	Millersburg	Holmes.
Roots, C. W.	Ass't County Draftsman	Cleveland	Cuyahoga.
		2152 Detroit St.	
Rosenstock, R.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		1059 Rose Bldg.	
Rosinsky, Chas. E.	Civil Engineer	Cincinnati	Hamilton.
		Waterworks Comnrs. Office.	
Row, W. C.	Surveyor	Circleville	Pickaway.
Royer, Henry	Surveyor	Louisville	Stark.
Ruggles, Ashbel P.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		1059 Rose Bldg.	
Ruggles, W. B.	Civil Engineer	Cincinnati	Hamilton.
		32 E. Second St.	
Russel, Samuel	Eng. M. of W., C. A. & C. Ry.	Akron	Summit.
Ryall, Geo. W.	Surveyor	Ashland	Ashland.

Sands, J. R.	Dep. County Surveyor	Athens	Athens.
Santarelli, Benj.	Civil Engineer and Sur.	Wilmington	Clinton.
*Sarver, Wm. E.	Ass't City Engineer	Canton	Stark.
Sayre, John W.	Civil Engineer and Sur.	Scott Town	Lawrence.
Schoenberger, A. F.	County Surveyor	Up. Sandusky	Wyandot.
Schultz, Chas. F.	Dep. Supt. of Waterworks	Cleveland City Hall.	Cuyahoga.
Schwab, C. N.	County Sur. and City Engineer	Napoleon	Henry.
Scott, E. A.	Civil Engineer and Sur.	Marion	Marion.
Scott, J. W.	City Engineer	Marion	Marion.
Scott, R. V.	Dep. County Surveyor	Cleveland New Court House.	Cuyahoga.
Searles, Wm. H.	Civil Engineer and Sur.	Cleveland 625 Hickox Bldg.	Cuyahoga.
Sebold, R. P.	Civil Engineer and Sur.	Dayton Beckel Bldg.	Montgomery.
Seever, F. N.	Civil Engineer and Sur.	Springfield	Clark.
*Seitz, D. W.	Dep. County Surveyor	Ottawa	Putnam.
Seward, John W.	Civil Engineer and Sur.	Tallmadge	Summit.
Shanks, Will	Deputy City Engineer	Kenton	Hardin.
Shannon, Neal	Civil Engineer and Sur.	Mt. Sterling	Madison.
Sharon, Wm.	Civil Engineer	Springfield	Clark.
Sharp, C. C.	Superintendent Sunday Creek Coal Co.	Corning	Perry.
Sharp, W. W.	Civil Engineer and Sur.	Rock Creek	Ashtabula.
*Sharts, R. S.	Dep. County Surveyor	Dayton	Montgomery.
Shaw, Eli D.	Civil Engineer and Sur.	Minerva	Carroll.
Sheldon, A. D.	Civil Engineer and Sur.	Whittlesey	Medina.
Sheldon, F. B.	Chief Engineer Hocking Valley Ry. Co.	Columbus	Franklin.
Sherman, C. E.	Ass't Prof. Ohio State University	Columbus	Franklin.
Sherman, W. J.	Civil Engineer and Sur.	Toledo 613 The Nasby.	Lucas.
Sickafoose, G. L.	Civil Engineer	Canton	Stark.
Sill, John S.	County Surveyor	Jefferson	Ashtabula
Slade, Charles	Ass't City Engineer	Greenville	Darke.
Slaymaker, W. H.	Civil Engineer	Port Clinton	Ottawa.
Smith, Chas. M.	Deputy Engineer	Celina	Mercer.
Smith, D. W.	Civil Engineer Hocking Valley Ry. Co.	Columbus	Franklin.
Smith, E. A.	Eng. W. & L. E. Ry. Co.	Norwalk	Huron.
Smith, Frank	County Surveyor	Hooksburg	Morgan.
Smith, Jos.	Civil Engineer	Cincinnati 906 Race St.	Hamilton.
Smith, M. J.	Ass't Eng. B. & O. Ry.	Zanesville	Muskingum.

Smith, Jos. W.	Surveyor	Otway	Scioto.
Smith, Solon	City Engineer	Jackson	Jackson.
*Snow, C. H.	City Engineer	Elyria.	Lorain.
Snyder, David F.	Civil Engineer and Sur.	Springfield	Clark.
Snyder, Frank	Draftsman Dept. Pub. Improvements	Columbus	Franklin.
Somerville, A.T.B	Civil Engineer and Sur.	Toledo	Lucas.
		The Monticello.	
Spafford, Elmer L	Civil Engineer and Sur.	Bowling Green	Wood.
Spangler, T. M.	Civil Engineer and Sur.	Pleasantville	Fairfield.
Spence, J. F.	Civil Engineer	Lisbon	Columbiana.
Spinks, Martin	Bridge Eng. Champion Bridge Works	Wilmington	Clinton.
Sprague, C. M.	Ass't Eng. P. C. C. & St. L. Ry.	Columbus	Franklin.
Springmeier, Fred	Civil Engineer	Cincinnati	Hamilton.
		859 Clinton St.	
Stanley, H. J.	Chief Eng. Bd. of Pub. Service	Cincinnati	Hamilton.
		City Hall.	
*Stattleman, G. R.	Civil Engineer and Sur.	Dayton	Montgomery.
		37 W. Washington St.	
Stever, F. S.	Surveyor	Defiance	Defiance.
Stewart, G. O.	County Surveyor	Shyville	Pike.
		Box 12.	
Stewart, Jas. A.	Civil Engineer	Cincinnati	Hamilton.
		517-518 Johnston Bldg.	
Stimson, Earl	Res. Eng. B. & O. Ry.	Cincinnati	Hamilton.
*Stinebaugh, I. L.	Dep. County Surveyor.	Port Clinton	Ottawa.
Stinehour, Ed. L.	Civil Engineer and Sur.	Akron	Summit.
Stone, C. E.	Civil Engineer	Gallipolis	Gallia.
Stratton, Jerome L	Civil Engineer and Sur.	Toledo	Lucas.
		115 Chamber of Commerce.	
Strawn, J. B.	Civil and San. Eng., Con. Eng. Water-works & Elec. Light.	Salem	Columbiana.
Strehler, Alfred	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		1115 Lorain St.	
Stringfellow, U. K	Civil Engineer and Sur.	Findlay	Hancock.
Sturtevant, J. W.	Ass't City Engineer	Cleveland	Cuyahoga.
		18 Eastman.	
Suerbier, F.	Surveyor	Oak Harbor	Ottawa.
Sullivan, Wm.	Surveyor	Gustavius	Trumbull.
Sullivan, W. E.	Asst. Eng. Bd. of Pub. Service	Cincinnati	Hamilton.
		City Hall.	
Sundmaker, J. H.	Ass't County Engineer.	Cincinnati	Hamilton.
		Court House.	

Sweetman, J. H.	Surveyor	Circleville	Pickaway.
Swigart, S. G.	Sur. and Civil Engineer	Akron	Summit.
Swisher, James	County Sur. and City Engineer	Urbana	Champaign.
Taggart, E. G.	County Sur. and City Engineer	Delaware	Delaware.
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Talbot, H. E. & Co	Civil Engineers and Contractors	Dayton	Montgomery.
		Cor. Eaker and Levee.	
*Talbot, O. C.	County Surveyor	Ottawa	Putnam.
Tatlock, J. L.	Ass't Eng. B. & O. Ry.	Cincinnati	Hamilton.
Taylor, A. R.	County Surveyor	Kenton	Hardin.
Taylor, George	Mining Engineer	Lima	Allen.
Taylor, L. A.	Civil Engineer and Sur.	Tinney	Sandusky.
Tharp, Willis P.	Civil Engineer	Cincinnati	Hamilton.
		810 Neave Bldg.	
Thiery, E. H.	County Surveyor	Owensville	Clermont.
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Thomas, J. O.	Ass't Wire Chief C. U. Telephone Co.	Columbus	Franklin.
Thompson, C. M.	Surveyor	Salesville	Guernsey.
Thompson, J. P.	Ass't Eng. Bd. of Pub. Service	Cincinnati	Hamilton.
Toberen, H. F.	County Sur. and City Engineer	Defiance	Defiance.
Tod, Geo., Jr.	Civil Engineer and Sur.	Youngstown	Mahoning.
Tolbert, O. C.	Civil Engineer and Sur.	Ottawa	Putnam.
Tomlinson, J. R.	Br idgeDraughtsman	Cleveland	Cuyahoga.
Tonson, Geo. W.	Northern Eng. Co.	Toledo	Lucas.
		1029 The Spitzer.	
Tozzer, Henry	Surveyor	Cincinnati	Hamilton.
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Trembly, Dr. J. M	Surveyor	Reiley	Butler.
Troyer, M. K.	Surveyor	Walnut Creek	Holmes.
Turner, F. M.	Ci' Engineer	Dayton	Montgomery.
		Room 8, City Bldg.	
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Uhl, John B.	Civil Engineer and Sur.	Toledo	Lucas.
		1037 The Spitzer.	
Van, Etta	Railroad Engineer	Nelsonville	Athens.
Van, Ocken	Engineer Bellefontaine Bridge Co.	Bellefontaine	Logan.

Vance, Chas. F...Civil Engineer and Sur. Balanga Batan, Luzon, Phillippine Islands.
*Varney, J. D....Civil Engineer and Sur. Cleveland .....Cuyahoga. 53 Public Square.
Veenfleit, ——....Civil Engineer ....St. Marys.....Auglaize.

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Walker, E. R.....Dep. County Surveyor..Athens ....Athens.
Walker, H. J.....City Engineer ....Troy ....Miami.
Walker, J. M....Ass't Res. Eng. B. & O. Ry. ....Chicago Junc...Huron.
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Wangler, Wm.... Mining Engineer ....Jackson ......Jackson.
*Ward, John C...Civil Engineer and Sur. Painesville ...Lake.
Ware, Joseph ....Surveyor ....Urbana ....Champaign.
*Warner, German. County Surveyor ....Greenville ....Darke.
Warner, H. R....Civil Engineer .... Stanwood ....Stark.
Warrington, H. E Ass't Eng. C., N. O. & T. P. Ry. Co........Cincinnati ....Hamilton. Odd Fellows' Temple.
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Weaver, J. C.....Dep. County Surveyor..Hamilton .....Butler.
*Weber, H. L....City Engineer ....Richmond, Ind.
Weber, Philip ....City Engineer ....Canton ....Stark.
*Webster, C. H..County Surveyor ....Toledo ....Lucas.
Webster, W. V...County Surveyor and Civil Engineer ......Cambridge ....Guernsey.
*Weddell, J. B...City Eng. at Shelby, O..Mansfield .....Richland.
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Wells, G. L.......Civil Engineer and Sur. Cleveland .....Cuyahoga. 908 New England Bldg.
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Wenz, Ferdinand. Dep. County Surveyor..Perrysburg ...Wood.
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West, W. H......Civil Engineer and Sur. Bentonville ...Adams.
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*White, Homer C. County Surveyor ....Warren ....Trumbull.
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Wickenden, T. R.	Park Engineer	Toledo	Lucas.
		602 Star Ave.	
Willard, C. E.	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		231 Pury St.	
Williams, A. K.	Eng. Raccoon Coal and Fuel Co.	Gallipolis	Gallia.
Williams, Fred	Civil Engineer and Sur.	Cleveland	Cuyahoga.
		732 Societv for Savings Bldg.	
Williams, Girard	Civil Engineer and Sur.	Madison Mills.	Fayette.
Wilson, C. A.	Chief Eng. C., H. & D. Ry.	Cincinnati	Hamilton.
		Carew Bldg.	
Wilson, G. W.	County Surveyor	Honesty	Noble.
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		City Hall.	
Wilson, O. P.	Dep. County Engineer	Kenton	Harding.
Wilson, R. E.	Civil Engineer	Waynesburg	Stark.
*Wilson, Wm.	City Engineer	Niles	Trumbull.
Winans, James	Civil Engineer and Sur.	Toledo	Lucas.
		25 The Nasby.	
Winterhalter, L P	Ass't City Engineer	Canton	Stark.
Wirthwein, L. P.	Civil Engineer	Columbus	Franklin.
Wise, D. M.	Civil Engineer and Sur.	Youngstown	Mahoning.
Witten, C. O.	Dep. County Surveyor	Van Wert	Van Wert.
Wolf, J. N.	City Engineer	Lancaster	Fairfield.
Wolfe, Arthur J.	Transitman N. & W. Ry.	Chillicothe	Ross.
Wolfe, Gregg D.	Draughtsman and Transitman Scioto Valley Traction Co.	Chillicothe	Ross.
*Wonders, J. C.	Civil Engineer	Bellefontaine	Logan.
Wood, Robt. J.	Engineer of Lakewood	Lakewood	Cuyahoga.
Wood, W. H.	Civil Engineer and Sur.	Bowling Green	Wood.
Wright, John R.	Dep. County Surveyor	Mt. Oreb	Brown.
Wulfekoetter, E. W., Jr.	Surveyor	Cincinnati	Hamilton.
		14 Hulbert Block.	
Yonst, Wm. C.	Civil Engineer and Sur.	Akron	Summit.

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